Field Evaluation Manual for Ohio's Primary Headwater Habitat Streams

Creek chub

Stonefly larva

Two-lined salamander

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Division of Surface Water
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Disclaimer:

This document was produced by the Ohio Environmental Protection Agency (Ohio EPA) as a tool to promote standardized assessment of primary headwater streams in Ohio. It is intended solely as a presentation of methods that Ohio EPA has developed to better assess the actual and expected biological conditions in these waterways, and it outlines an acceptable methodology on how to classify primary headwater habitat streams as provided in paragraph (C)(6)(m) of rule 3745-1-05 of the Ohio Administrative Code (OAC). However, it does not represent an officially sanctioned policy or regulation of the Ohio EPA. All statements regarding aquatic life use designations for primary headwater streams should be read with the understanding that new use designations require revisions to Ohio's water quality standards regulations (OAC Chapter 3745-1) through an administrative rule making process. Ohio EPA expects to learn more as these methods are applied and this additional experience will determine what rule revisions are appropriate.

This manual revises prior documents made available to the public on standardized sampling in primary headwater streams (Davic, 1996; Anderson et al. 1999; Ohio EPA, April 2001). Aspects of this manual may change as new information is made available. In the future, the Ohio EPA may consider inclusion of these methods in "Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices" (Ohio EPA 1997, as updated). Questions regarding Ohio EPA water quality standard regulations, and aquatic life use designations, should be directed to the Division of Surface Water, PO Box 1049, Columbus Oh 3216-1049 (614-644-2876).

Acknowledgments:

This 2002 revision of the manual was edited by Robert D. Davic, Ph.D., Division of Surface Water, Northeast District Office, 2110 East Aurora Road, Twinsburg, Ohio 44087. Technical questions regarding this manual should be directed to him at: (330) 963-1132 *or* via e-mail: robert.davic@epa.state.oh.us. Primary investigators for the Ohio EPA primary headwater stream assessment program were Paul Anderson, Mike Bolton, Robert Davic, and Steve Tuckerman; under the direction of project coordinators Dan Dudley and Bill Schumacher. Other members of the Ohio EPA Headwater Habitat Work-Group whom contributed technical review and/or field data were: Jim Grow, MaryAnne Mahr, Louise Snyder, Ric Queen, Chris Skalski, Ed Rankin, Hugh Trimble, and Chris Yoder. We acknowledge the significant efforts of numerous Ohio EPA summer interns, and staff from Lake County Soil and Water Conservation District, for their contribution to collection of data. We also thank members of the Ohio Academic Panel, that was convened by Dr. Gene Willeke of Miami University (Ohio) for their valuable technical comments on sampling procedures found in the 2001 draft version of this manual.

Conversions:

Throughout this manual various metric and English measurement units are cited due to different protocols established in the engineering and basic sciences. Some useful conversions are given below:

To covert	into	Multiply by
Square mile	hectare	259
Square mile	square kilometer	2.590
Feet	meters	0.3048
Inches	centimeters	2.540
Miles	kilometers	1,609
Hectares	acres	2.471
Celsius	Fahrenheit	(1.8 C) +32
Fahrenheit	Celsius	5/9 (F -32)

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Preface:

The Federal Clean Water Act provides for "maintaining the biological integrity of the nation's waters", from the mouths to the headwaters. In carrying out the regulatory responsibilities for streams in the State of Ohio, there is a need for a methodology that deals with proposed activities in the extreme headwaters areas, what Ohio EPA calls "primary headwater habitat" (PHWH) streams. It is well established in the scientific literature that headwater streams of the kind addressed in this manual are important to the quality of water and biological communities in larger streams to which these primary headwater streams are tributary.

The primary headwater streams addressed in this manual are quite small, less than 1.0 m^2 drainage area. Many of them would not show up as blue lines on USGS 1:24,000 quadrangle maps, although almost all of them would be visible and marked on county soil maps. These streams are not often defined or assigned beneficial uses in Ohio water quality standards. The sampling methods, and concurrent biological and habitat indices now used by OEPA to classify waterways for existing water quality (e.g., IBI, ICI, QHEI) are oriented toward larger streams. Because these "index of biotic integrity" assessment systems are watershed size dependent, they often cannot be used to identify the well being of the native fauna that survive and reproduce in small headwater stream ecosystems.

In the absence of comparable measures of stream quality for extreme headwaters, government agencies responsible for protection of water resource integrity may appear to be arbitrary if they seek to approve or deny a permit or certification application to lower water quality in primary headwater streams. The stream classification methodology presented in this manual helps to fill that void, in a manner similar to the Ohio EPA (ORAM) sampling methods now being used to classify jurisdictional wetlands. This primary headwater stream manual outlines a predictable three-tiered protocol that can be used to conduct rapid assessment of headwater stream quality. The lowest level of field effort is a relatively rapid habitat evaluation procedure known as the "Headwater Habitat Evaluation Index" (HHEI). It is based on three physical measurements that have been found to correlate well with biological measures of stream quality. Two levels of biological assessment, one at a order-family level of taxonomic identification, the second to genus-species, provide flexibility in reaching a final decision on the appropriate aquatic life use designation needed to protect the native fauna of any primary headwater stream.

The great number of primary headwater streams in Ohio, their diverse ecological functions, and their value to the well being of the larger rivers, lakes, and wetlands to which they are tributary underscores the importance of their proper classification and protection.

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1.0 INTRODUCTION and RATIONALE

This document revises the draft Ohio EPA (2001) field evaluation manual for primary headwater habitat (PHWH) streams. Included in this revision are modified field data forms and scoring criteria for the HHEI (habitat evaluation) and HMFEI (benthic macroinvertebrate evaluation). The forms and methods in this 2002 revision supercede the previous draft manual made available by the Ohio EPA for assessment of primary headwater habitat streams (Ohio EPA, 2001).

The methods in this manual are calibrated to assessment of a primary headwater habitat stream (PHWH-stream). ***A primary headwater habitat stream is a surface water of the state, as defined in Ohio Administrative Code 3745-1-02, having a defined bed and bank, with either continuous or periodical flowing water, with watershed area less than or equal to 1.0 mi^2 (259 ha), and maximum depth of water pools equal to or less than 40 cm.***

Primary headwater streams are the very smallest swales and streams that are the origin of larger water bodies in the state. The chemical, physical, and biological quality of larger streams and lakes have a close connection to the overall health of headwater streams and their watersheds. Primary headwater streams provide important economic and ecological functions through the retention of sediment, water, and organic matter; nutrient reduction; and by providing corridors for wildlife dispersal (Ohio EPA, 2000a; Meyer and Wallace, 2001; Peterson et al., 2001). They may harbor a unique native fauna of temperature sensitive vertebrates (fish and/or amphibians), benthic macroinvertebrates, and aquatic plants where flows are permanent. These streams are a natural extension of the stream continuum concept (Figure 1), which identifies how larger streams in a watershed are dependent on chemical and biological processes that occur in the smaller streams that flow into them.

Some think of small streams and ditches as nuisances or merely storm water conveyances, and the concept that cumulatively these waters can have substantial consequences on downstream water quality is not well known to the general public.

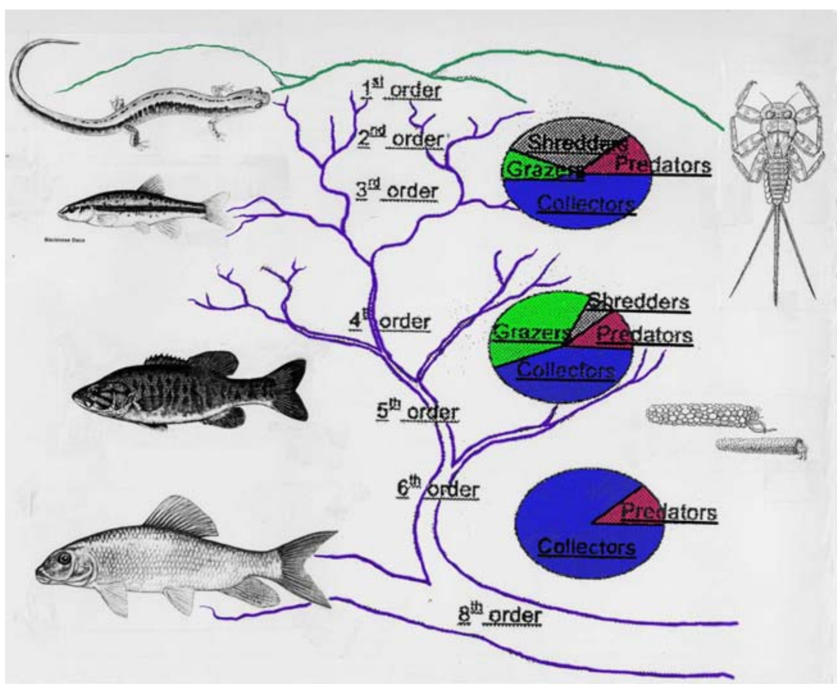

Figure 1. The river continuum concept and its relationship to biological communities found in primary headwater streams.

The primary objective of the federal Clean Water Act (Sec. 101 a) is "to... maintain the ... biological integrity of the nation's waters", a goal that clearly applies not only to large rivers but also to the smaller headwater streams of the nation's watersheds. Primary headwater streams that connect to other flowing waters are defined as "waters of state" in the Ohio Revised Code (ORC 6111.01). Discharges from point sources into small streams and drainage channels are regulated by NPDES permits as discharges to waters of the state.

Most primary headwater streams are not defined or assigned designated uses in Ohio water quality standards (Ohio Administrative Code, Chapter 3745-1), although they do have a "general high quality water" existing use classification in the antidegradation section 3745-1-05 (E) (1) of OAC. Water quality standards consist of designated uses and water quality criteria that protect those designated uses (see Section 303 of CWA). In Ohio, water quality criteria contain both chemical and biological components (OAC Chapter 3745-1-07). Current biological criteria (fish-IBI and macroinvertebrate-ICI) and sampling methods that apply to larger streams are not appropriate for many primary headwater streams given their small size and lack of deep pools. In addition, the relationship between hydrology, geomorphology, and biotic potential of primary headwater streams in Ohio is poorly understood.

Recognizing these limitations, from 1999 to 2001 the Ohio EPA conducted a statewide biological, chemical, and physical habitat evaluation of PHWH streams located within four of the major ecoregions of Ohio (Figure 2). This evaluation was a continuation of a primary headwater stream assessment initiative that has been made available to the public by Ohio EPA over the past decade (Davic, 1996; Anderson, et al, 1999; Ohio EPA, 2001).

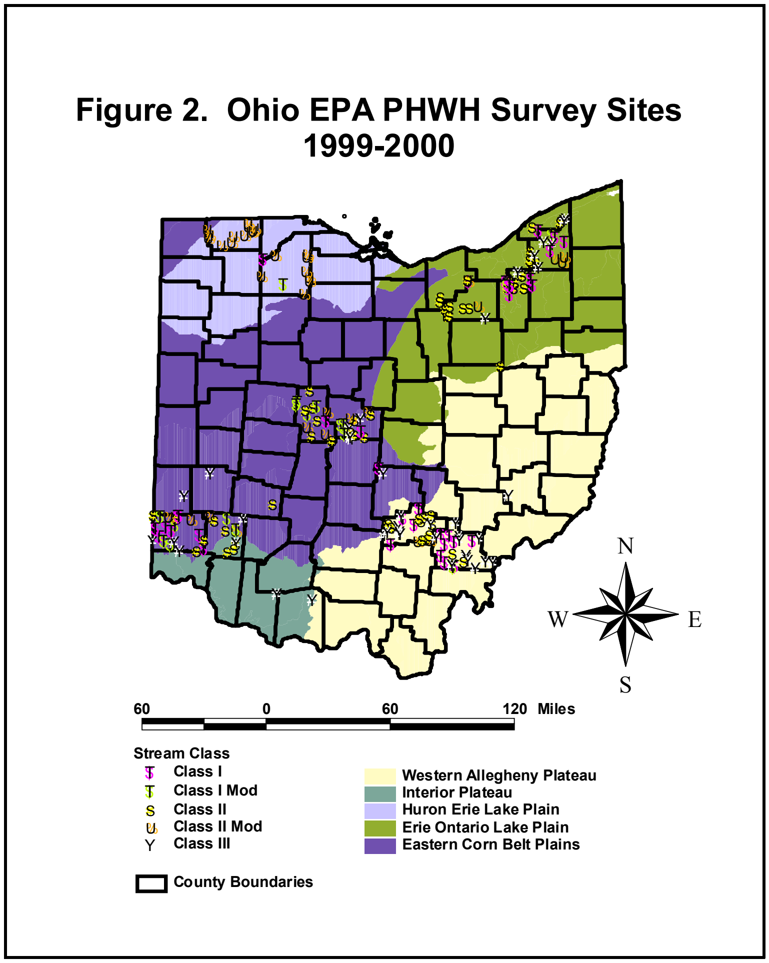

Figure 2. Primary Headwater Habitat (PHWH) stream sample locations. Boxes represent 1999 samples, circles with dots are 2000 samples, and solid circles are Lake SWCD samples.

Fifty-nine PHWH streams were surveyed in 1999 with an additional 215 streams randomly sampled in 2000 from 5 rapidly developing areas in 10 Ohio counties. In 2001, 18 streams were sampled for seasonal trends (benthic macroinvertebrates), and additional data were collected from select counties. Detailed information on the results of these surveys will be made available in separate technical reports (Ohio EPA 2002 a,b,c)

In general, the results of this monitoring program indicate that two fundamental types of biological communities are present in the primary headwaters of Ohio:

(1) streams found to have native fauna adapted to cool-cold perennial flowing water characterized by a community of vertebrates (either cold water adapted species of headwater fish and/or obligate aquatic species of salamanders from the lungless family Plethodontidae), and/or a diverse community of benthic macroinverterbates including cool water taxa, with larval life stages resident in the stream continuously on an annual basis. This type of PHWH stream is herein referred to as a **Class III-PHWH stream**.

(2) streams found to have a moderately diverse community of warm-water adapted native fauna either present seasonally or on an annual basis. The native fauna of these streams is characterized by species of vertebrates (fish or salamanders) and/or benthic macroinvertebrates that are pioneering, headwater, temporary, and/or temperature facultative. This type of PHWH stream is herein referred to as a **Class II-PHWH stream**.

A certain percentage of the primary headwater stream channels were observed to be normally dry, with little or no aquatic life present. This type of primary headwater waterway that is normally ephemeral, with water present for short periods of time due to infiltration from snow melt or rainwater runoff, is herein referred to as a **Class I-PHWH stream**.

The primary <u>physical habitat</u> distinction between a Class I and Class II-PHWH stream is the presence of flowing water or isolated pools for extended periods of time in Class II-PHWH stream channels during summer months. The primary <u>biological</u> distinction is that Class I-PHWH streams either have no species of aquatic life present, or if present, it is of relatively poor biological diversity.

The Three Types of Primary Headwater Streams in Ohio:

(1) **Class III-PHWH Stream (cool-cold water adapted native fauna)**
(2) **Class II-PHWH Stream (warm water adapted native fauna)**
(3) **Class I- PHWH Stream (ephemeral stream, normally dry channel)**

In conjunction with the biological sampling conducted from 1999 to 2001, multiple measurements of numerous physical habitat variables were made at 274 PHWH stream locations following field methods in Anderson et al. (1999). The purpose of this sampling was to determine the feasibility of using a rapid assessment of physical habitat variables to predict, with a high degree of statistical confidence, the biological characteristics of a primary headwater stream. Using methodologies similar to those employed to develop the Qualitative Habitat Evaluation Index (Rankin, 1989), a Headwater Habitat Evaluation Index (HHEI), was constructed. The HHEI can be used to score physical habitat features that have been found to be statistically important determinants of biological community structure in PHWH streams with drainage area less than 1 mi^2 (259 ha).

The HHEI assessment is similar to, but different from, the "Habitat Suitability Index" approach used by the U.S. Fish and Wildlife Service to predict ecological habitat requirements for specific wildlife species (U.S. Fish and Wildlife Service, 1981). The Habitat Suitability Index (HSI) uses measures of habitat variables to predict life history characteristics of individual species of wildlife. In contrast, the HHEI approach uses measures of habitat variables to predict the presence or absence of an assemblage of cold-cool water adapted vertebrates (fish and/or lungless salamanders) and benthic macroinvertebrates. Statistical analysis of a large number of physical habitat measurements showed that three habitat variables (<u>channel substrate composition</u>, <u>bankfull width</u>, and <u>maximum pool depth</u>) are sufficient to statistically distinguish Class I, II, and III-PHWH streams. Assigning positive and negative weighted scores to these three habitat variables results in the formation of a final composite HHEI score. The HHEI rapid assessment tool is most predictive when "modified" channels (e.g., channels modified by relocation, channelization, dredging) are separated from "natural" channels that have little or no evidence of channel modification. Thus indirectly, the final HHEI scoring process incorporates many more aspects of the geomorphology and hydrology of small stream channels (i.e., entrenchment, degree of sinuosity, etc.) than the limited set of three variables that require quantitative measurement.

The headwater stream network of watersheds is complex, and the proportions of the three different primary headwater stream classes differs among ecoregions in Ohio (OSU, 2001). Some waterways do not have a defined stream bed and bank, and thus fall outside the concept of a headwater "stream". These <u>non-stream waterways</u> contribute about 18.4% of the total primary headwater drainage network in Ohio (Table 1). The average stream miles of the different types of streams estimated in Ohio are shown in Table 1. These statistics come from data collected by Ohio EPA during the year 2000 random survey of primary headwater streams in various ecoregions. Manmade roadside ditches that are not a continuation of a natural stream channel would also be included in the non-stream waterway designation.

The type of biological community found in primary headwater streams can shift abruptly from one PHWH stream class to another, such as when cold spring-fed groundwater flow intercepts a dry stream channel (e.g., Class I stream becomes a Class III). Other changes in species composition are gradual, e.g., when a cold Class III stream is sequentially diluted by warmer rain infiltration water. Yet other primary headwater streams maintain the same type of biological community throughout their length. Terminology that relates hydrology to the different classes of PHWH streams is provided in Table 2, and Figure 3.

Table 1. Summary of estimated miles of flowing waterways in Ohio. Statistics from OSU (2001).

Waterway Type	Length in Miles	Percent of Total
Named Streams		
(ODNR, USGS blue lines)	21,048	12.61 %
Unnamed Streams *		
Class I- PHWH	36,405	21.80
Class II-PHWH	51,250	30.69
Class III-PHWH	27,551	16.51
Unnamed Waterways		
Non-stream waterways #	30,708`	18.39
Total of all types: mean	166,962	100 (rounded)
95% Upper CI of mean	250,636	

* A random site selection statistical approach was used to estimate the total length of "unnamed stream" miles. This value would include intermittent blue lines on USGS topographic 7.5 min. series maps.

Non-stream waterways do not have a well defined bed-bank, thus they do not meet the concept of a "primary headwater stream" however, they do meet the definition of "waters of the state" in Ohio Revised Code, Section 6111.

A number of PHWH streams in Ohio are channelized, often with significant removal of riparian vegetation. Hydro-modification is now the leading source of impairment of Ohio streams (Ohio EPA, 2000). Channelization leads to physical habitat degradation and sedimentation problems that are now the two leading causes of impairment of Ohio's surface waters. Many channelized PHWH streams were modified before current Clean Water Act Section 404/401 regulations were put into place, which now require federal permit and state water quality certification for any modification of a stream channel that adds dredge or fill material to a primary headwater stream channel.

Many different hydrological terms relate to the three classes of PHWH streams described in this manual. Terms such as perennial, permanent, continuous, intermittent, temporary, interrupted, and ephemeral are routinely used to describe the type of flow present in stream channels. The relationship between hydrology and potential PHWH stream class is summarized in the box below (see also Figure 3 and Table 2). For example, a perennial flowing PHWH stream may have either Class III (cool-cold water) or Class II (warm water) type of biology present, with the primary difference being water temperature, not flow.

Perennial flow (continuous, permanent)	= either Class III or Class II PHWH stream
Interstitial flow (interrupted)	= either Class III or Class II
Intermittent flow (temporary, summer-dry)	= Class II
Ephemeral flow	= Class I

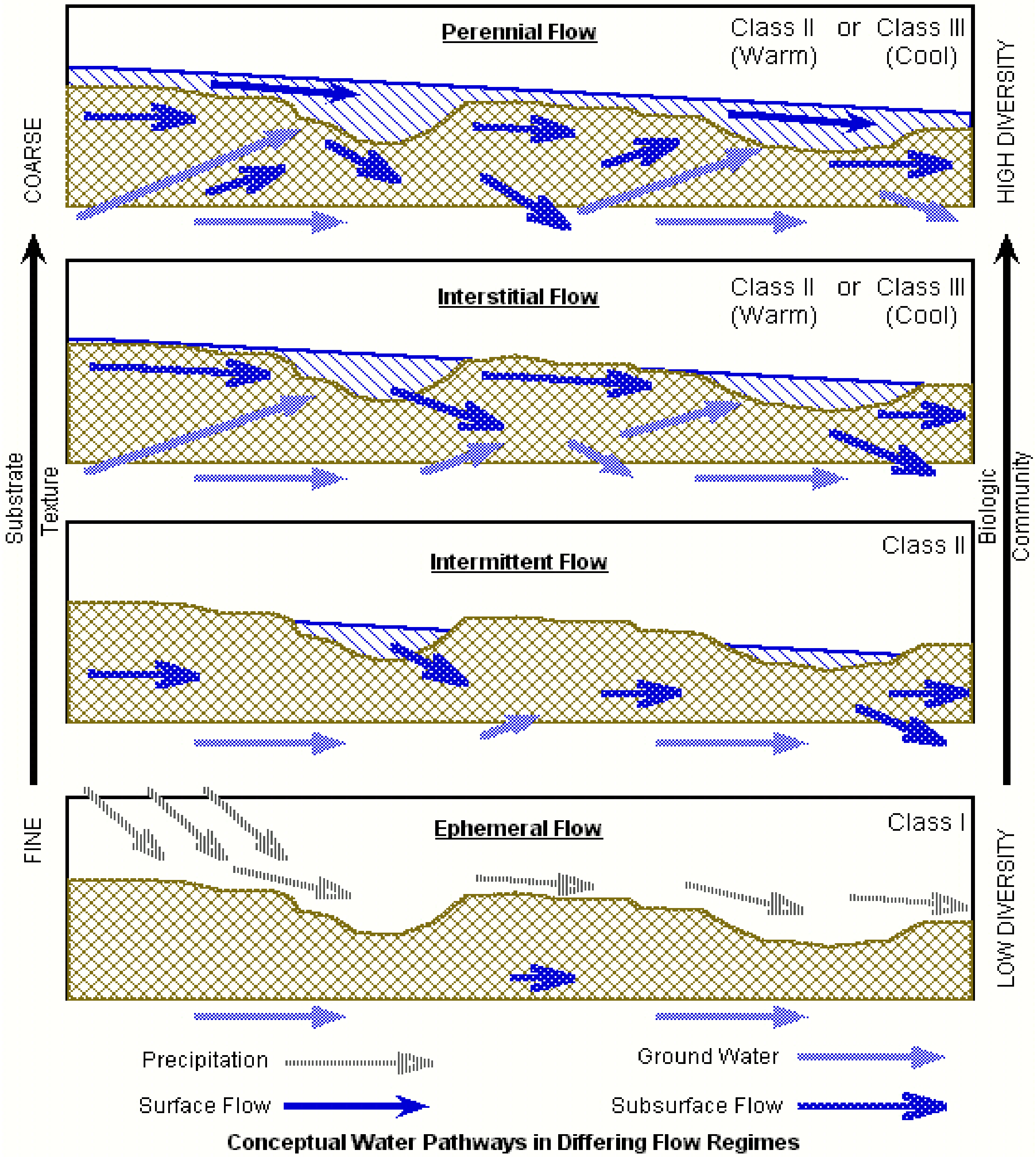

Figure 3. Conceptual water pathways in different types of PHWH streams.

Table 2. Suggested terminology to identify different types of hydrology associated with biological communities and stream classes in primary headwater streams in Ohio. See also Figure 3.

"**Continuos flow**". Water that flows permanently in a stream channel. Also referred to as "**perennial**" or "**permanent**" flow. There are two general types of continuos flowing primary headwater streams:

(a) "**Suprafacial flow**".[**] Streams with continuous flow on the surface of the stream bed substrate. Streams with suprafacial flow maintain surface flowing water at most times of the year (except for years of extreme drought) due to constant infiltration of surface runoff and/or groundwater recharge from subsurface aquifers. These streams may have Class II PHWH biology (if warm in summer) or Class III PHWH biology (if cold-cool in summer).

(b) "**Interstitial flow**". Streams with continuous flow that occurs seasonally under the surface of the stream bed within the interstitial spaces of course substrate, or cracks in bedrock. Also called "**interrupted flow**". Streams with interstitial flow have visually dry stream beds with isolated pools of water that are hydraulically connected by slowly moving water. At times of sustained drought, this type of stream may only have water flowing within the subsurface alluvium. The perennial flow is maintained by either deep groundwater recharge from the water table, or from surface wetlands. These streams can maintain either a Class II (if warm in summer) or Class III type biology (if cold-cool in summer) in isolated pools of water, or in the interstitial spaces of the subsurface hyporheic zone, depending on the origin of the flowing water. The biology in warm water interstitial streams tends toward the intermittent stream type during sustained drought.

"**Periodical flow**". Water that stops flowing along the stream channel during periods of no precipitation and/or groundwater recharge. There are two general types of periodical flow:

(a) "**Intermittent flow**". Also called "**temporary flow**", or "**summer-dry**" type of stream. These streams have flow for extended periods of time seasonally, but gradually reach a state where there are either isolated pools of water that are not hydraulically connected by sub-surface flow, or a dry channel. Biology may be present in wet hyporheic subsurface substrate. Usually have a warm water Class II type of biology present from roughly October to June.

(b) "**Ephemeral flow**". These streams are normally dry and only flow during and after precipitation runoff (episodic flow). These streams normally have a dry stream channel with no evidence of isolated pools of water. May have Class I type biology present seasonally in the spring.

[**] note: The roots of the term suprafacial flow are: **supra**=above or surface; and **facial**=on the face of.

2.0 METHODS and PROCEDURES

The methods in this manual are based upon measurement of biological, chemical, and physical (HHEI) habitat characteristics that can be used to determine the existing aquatic life use for a primary headwater stream. A PHWH assessment should only be conducted after it has been determined that the stream under investigation has no possibility of supporting a well balanced fish community as measured by the fish-IBI, and that other potential aquatic life use designations as found in OAC Chapter 3745-1 are not appropriate (i.e, Warmwater Habitat-WWH; Exceptional Warmwater Habitat-EWH; or Coldwater Habitat-CWH). As a rule of thumb, any stream with a watershed area greater than 1.0 mi^2 (259 ha), <u>*or*</u> with pools having a maximum depth over 40 cm, should first be evaluated using the QHEI and biological sampling methods appropriate for WWH, EWH, CWH, or MWH, aquatic life use designations (Ohio EPA, 1989; Rankin, 1989).

All field observations and physical and biological data collected during the assessment are to be recorded on the Ohio EPA Primary Headwater Habitat Stream Evaluation (PHWH) form included as Attachment 1 of this manual. An overview of the sequence of tasks involved in a PHWH stream evaluation is found on page 43 of this manual. Field personnel conducting these assessments should obtain permission from property owners to gain access to the streams, and any necessary State or Federal permits for conducting biological collections, prior to conducting the assessment.

2.1 Desktop Evaluation and Background Information

2.1.1 Mapping Scale

The *potential* location of a PHWH stream in the landscape can be identified using the USDA, National Resources Conservation Service (previous SCS) soil survey maps that are available for each of the 88 counties in Ohio (Figure 4). Different terminology is used in the various county soil surveys to identify potential PHWH streams. Terms such as drainage, stream-perennial, stream-intermittent, stream-unclassified, ditches, springs, drainage end, alluvial fan, etc. are used to identify small watercourses on these county soil maps. Each of these watercourses that connect to downstream surface waters of the state are potential PHWH streams. County soil survey maps can be obtained at county NRCS offices, and at many local and university libraries.

The NRCS mapping scale represents the most detailed knowledge of the distribution and abundance of *potential* primary headwater streams in Ohio. A common soil mapping scale is 1:15,840, but others do exist. Because the field and aerial survey data shown on many county soil survey maps were collected prior to 1970, a field assessment of a property may show that a potential PHWH stream has been relocated or placed in a drainage culvert. In some rare cases, a PHWH stream observed to be present during a site visit will not be shown on a county soil map, but may be shown on a USGS topographic map. Thus both NRCS and USGS maps should be consulted to determine if any PHWH streams are potentially present.

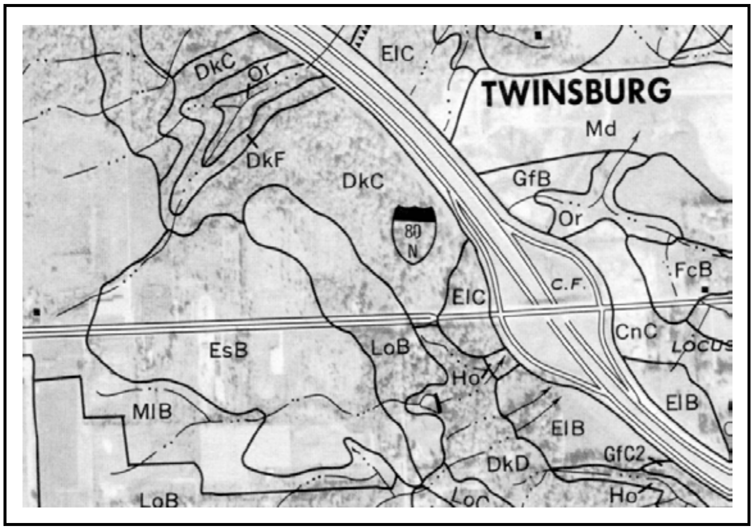

Figure 4. Representative NRCS (aka SCS) County Soil Map showing location of Primary Headwater Habitat (PHWH) streams in a local watershed. First order PHWH streams are those primary streams at the uppermost limits of the drainage network, two first order PHWH streams merge to form a second order stream, and so on until the drainage empties into a larger stream that has a specific designated use. Streams in Ohio with designated uses are found in OAC, Chapter 3745-1. Total area shown in this figure is about 0.63 mi^2 (163 ha).

2.1.2 When to Sample

A biological or HHEI physical habitat assessment can be conducted at any time of the year, but must be conducted when the stream is at baseflow conditions for that time of year. Baseflow conditions in small headwater streams recover quickly after rain events, usually within 24 hours. Biotic sampling during drought conditions can result in mis-classification of biotic potential. OAC Chapter 3745-1-01 (D) indicates that water quality standards, and hence attempts to assign aquatic life designated uses, will not apply to water bodies when the flow is less than criteria low flow values as determined in rule 3745-2-05 of OAC. Lacking other information, the Q 7-10 value from the nearest hydrologic unit as reported by the U.S.G.S. can be used to estimate critical low flow on the date of assessment. The Q7-10 flow is used in OAC 3745-2-05 (A) to protect the chronic aquatic life potential of surface waters in Ohio.

The HHEI habitat evaluation can be used at any time of the year to determine *potential* existing stream use, with the understanding that the HHEI metrics have been selected, and weights adjusted, to allow for statistical protection of Class III-PHWH streams. A sampling period of June thru September will best distinguish the various classes of PHWH streams, however biological sampling can be conducted at any time of the year. Vertebrates that live in cool spring-fed PHWH streams are present throughout the year because they are adapted to permanent flow conditions. For amphibians, it is the gilled larvae that are most sensitive to stream dessication. Collection of a benthic macroinvertebrate voucher sample to verify the presence or absence of cool water adapted taxa also can be conducted at any time of the year. Likewise, a rapid bio-assessment of benthic macroinvertebrates using the HMFEI procedure also can be used at any time of the year, but is more representative during the summer sampling period (July to September). There is a taxa increase associated with spring emerging macroinvertebrate fauna (January to May) and sampling efficience may decline latter in the year due to leaf-fall (October to December).

When multiple samples are collected at the same location at different times of the year, the measurements taken during the July thru September time period shall be used to distinguish PHWH stream classes. When multiple samples are collected within the July thru September time period, the lowest stream classification score obtained will apply. Special precautions should be used when sampling from October thru December after leaf-fall has occurred. Accumulated leaf litter present in small streams at this time of the year can mask stream substrate conditions and make it difficult to visually locate stream dwelling vertebrates. For dry stream channels, conduct at a minimum a HHEI habitat evaluation.

2.1.3 Equipment Check List

An equipment checklist needed to conduct chemical, physical and biological measurements is included as Attachment 2 of this manual.

2.1.4 Reference Materials

Sources of reference for conducting physical stream measurements can be found in Rosgen (1996) and Rankin (1989). Field chemical sampling follows procedures as given in the Manual of Ohio EPA Surveillance Methods and Quality Assurance Practices (1997 revision). Recommended reference materials for macroinvertebrate taxonomic identifications are Merritt and Cummins (1996), and Pennak (1989). To identify potential cool-cold water adapted species of benthic macro-invertebrates detailed taxonomic keys following Ohio EPA, DSW, Ecological Assessment Section guidance must be used.

Fish should be identified using Trautman (1981), "The Fishes of Ohio". Salamanders should be identified to the species level using "The Salamanders of Ohio" (Pfingsten and Downs, 1989), and/or "Salamanders of the United States and Canada" (Petranka, 1998). Both of these references have keys for adults and larvae with numerous photographs of various life stages of salamanders found in Ohio. Another useful reference for Ohio amphibians is the Field Guide to Reptiles and Amphibians by Conant and Collins (1991). Pfingsten (1998) provides updated range distribution maps, by county, for amphibians in Ohio.

2.2 Stream Reach Delineation and Site Selection

2.2.1 PHWH Streams and Stream Reaches

The PHWH stream evaluation process consists of a combination of physical, chemical, and biological characterization of a **primary headwater stream reach**. For the purposes of a PHWH evaluation process, *a stream is herein defined as a surface watercourse having a channel (as defined in ORC 6105.01) with well defined bed and banks, either natural or artificial, which confines and conducts continuous or periodical flowing water.*

A stream reach is herein defined as a stream (*sic*) with a continuous channel bed up to 200 ft (61 m) length, a modification of the stream reach concept adopted by the Government of British Columbia (1998). Stream reaches for a PHWH assessment may be shorter than 200 ft in situations where tributaries have a junction with mainstem PHWH streams. Such tributaries will usually be "first order" streams at the NRCS county soil mapping scale (see Figure 4). Where deemed appropriate, these first order tributaries can be evaluated as being part of the larger PHWH mainstem. The mainstem of a PHWH stream drainage is the channel with the longest length that forms a junction with a larger named stream (see Figure 5).

Discrete stream reach boundaries are used to divided the stream channel into consecutive watercourse units for standardized assessment. At the headwaters of a watercourse, the location of the upper boundary of the uppermost stream reach is the location where the first (or last, depending on direction of travel) evidence is found of scour through the mineral substrate or alluvial deposition (Government of British Columbia, 1998). A 200 ft distance was selected because this was the distance used to calibrate the association between biological and habitat variables during the 1999 and 2000 calibration survey. This length of stream allows for a complete assessment of the natural scale of habitat variability that is present in these types of headwater streams. A 200 ft distance is also used in the CWA Section 404/401 permit/certification review process to determine applicability of Section 404/401 Nationwide Permits.

After the stream reach boundaries are mapped and identified then the physical, chemical, and biological characteristics of the stream can be determined. If any change in land use or channel character occur within a stream reach, they should be noted during the site visit. The stream delineation always begins at the most lower downstream location, or the lower limits of a property boundary, as shown in Figure 5. If a stream reach is dissected by natural geological features such as a bed-rock outcropping, the length of the stream reach for assessment can be adjusted accordingly.

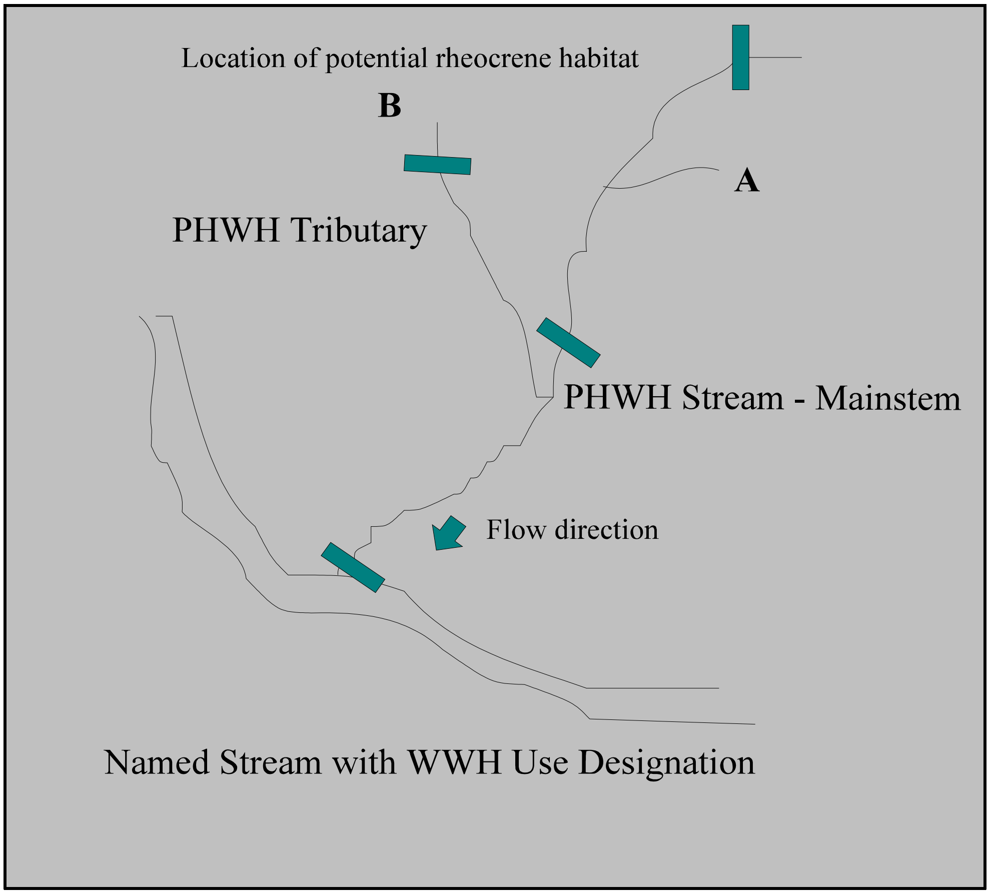

Figure 5. Hypothetical relationship of the **primary headwater <u>stream reach</u>** concept, showing 200 ft (61 m) upper and lower reach boundaries (dark rectangles). Delineation always begins at the most lower downstream location (or the lower property boundary). Total length of PHWH stream mainstem in this example is 430 ft (131 m). Small tributary (A) in upper zone of the PHWH mainstem may be included in assessment of that stream reach, or it may require its own assessment if it differs significantly from the mainstem conditions. PHWH tributary (B) receives its own 200 ft (61 m) stream reach assessment. The small section above the upper reach boundary for (B) may be included in the assessment of the lower 200 ft (61 m) section. The stream section near (B) would represent the *potential* location of a "rheocrene" habitat. The river mile (RM) where PHWH mainstem empties into the WWH designated stream should be recorded, as well as the RM location where PHWH tributary (B) empties into the PHWH mainstem.

2.2.2 Site Selection

It is anticipated that sampling of PHWH streams will occur for a variety of reasons:

(1) to delineate the total number, and total linear feet, of different classes (I, II, III, modified types) of primary headwater streams present within a specified property boundary (for example, as required for a CWA Section 401 water quality certification);

(2) to delineate the relative number and percentage of PHWH stream types that may be impacted by extensive road building, pipeline, or power line projects that may affect many 100's of potential PHWH streams;

(3) to allow a determination to be made of the proper aquatic life existing use classification to be given to an undesignated primary headwater stream corridor, as may be required for an NPDES permit application;

(4) to determine if a wastewater discharge, or other environmental alteration, is having a significant impact on the chemistry and/or biology of a primary headwater stream.

In the first situation above, all PHWH streams on the property should be mapped and delineated using 200 ft stream reach assessments. In the second situation, photographs and HHEI evaluations at discrete locations where PHWH channels will be crossed can be used to quickly estimate the relative percentage of different PHWH classes that will potentially be impacted by various project routes across the landscape. In the third situation, a multiple number (3-5) of discrete 200 ft stream reach assessments should be conducted along the length of the mainstem PHWH channel. Areas of recent habitat modification should be avoided in these types of PHWH assessments. In the fourth situation, 200 ft stream reaches should be identified upstream (reference site) and downstream from the wastewater discharge, or source of impact. Potential chemical impacts should be evaluated against water quality criteria found in OAC Chapter 3745-1. Potential biological impacts should be evaluated using the sample methods found in this manual.

2.3 QHEI *vs* HHEI Evaluation in Headwater Streams

If watershed size is greater than 1.0 mi^2 **<u>or</u>** natural deep pools are greater than 40 cm regardless of watershed size, a Qualitative Habitat Evaluation Index (QHEI) evaluation should be completed in accordance with standard Ohio EPA procedures (Rankin, 1989). The QHEI evaluation can be used to determine if the stream has potential to support a WWH community of fish, and has been used to assign aquatic life use designations for streams with drainage areas greater than 1.0 mi2. The decision making flow chart found in Figures 15 and 16 of Rankin (1989) should be used to determine if the stream has WWH potential using the QHEI technique. The stream length for a QHEI evaluation in a headwater stream should extend a minimal distance of 100 m and should cover the entire 200 ft PHWH stream reach.

If deemed appropriate by a qualified biologist, a HHEI habitat evaluation can also be conducted in conjunction with the QHEI evaluation in streams where watershed area is less than 1.0 mi^2 , but deep pools are greater than 40 cm, to insure correct classification of the aquatic life use potential. These types of decisions are best left to a biologist trained in the use of both the QHEI and HHEI evaluation methods. However, the HHEI should not be used in rheocrene habitats (see discussion on p. 15), nor in streams with drainage areas greater than 1.0 mi^2, since it was not calibrated for these types of habitats. Dry stream channels should have at a minimum an HHEI habitat evaluation conducted.

2.4 Rheocrene Habitats and Seepage Areas

Where deep groundwater (saturated zone) suddenly emerges to the land surface from an underground aquifer, a "spring" type aquatic habitat is formed. There are three general types of springs: (1) those that form a well defined channel (rheocrene); (2) those that form small pools or basins (limnocrene); and (3) those that form a marsh, or swamp (helocrene). Springs are unique freshwater ecosystems because their physical and chemical environments are usually more stable. In Ohio, persistent springs are of cold groundwater origin and maintain relatively constant temperatures throughout the year. They are warmer in winter and colder in summer than surface water recharge streams. Hot springs are not known to exist in Ohio. The type of biology present in springs will vary according to the type of spring that is formed (i.e., rheocrene, limnocrene, helocrene). Helocrene habitats are best evaluated using Ohio EPA wetland monitoring techniques (Mack, 2001; Micacchion, 2002), which are available online at:
[http://www.epa.state.oh.us/dsw/wetlands/wetland_bioasses.html].

For the purposes of a PHWH stream assessment, the *potential* location of a "rheocrene" type of habitat will be identified if the stream under investigation has constant flowing water, forms a defined bed-bank, <u>and</u> has a watershed size less than 0.1 mi^2 (25.9 ha). Because the HHEI physical habitat assessment was not sufficiently calibrated to identify biological communities in rheocrene habitats, it should not be used in this type of habitat. Following the decision making flow chart on page 23, a biological survey for amphibians and benthic macroinvertebrates must be conducted if a potential rheocrene is suspected. The proper PHWH stream classification to be given to waterways that meet the definition for a rheocrene habitat will be based on the types of vertebrate and benthic macroinvertebrate species present, as determined by the biological methods outlined in Section 2.5.11 of this manual. Seepage areas with diffuse flow that have wide and very shallow channels, and do not have a defined bed-bank, fall outside the assessment methods of this manual, however, they may be wetlands, thus the wetland assessment methods of Ohio EPA (Mack, 2001; Micchhichon, 2002) may apply. The habitat comprising the zone of saturated sediments beneath and adjacent to an active stream channel that is available for aquatic organisms is called the *hyporheic zone*. This zone is the biologically and chemically active interface or ecotone among the atmosphere, land, surface waters and ground waters. This manual does not address sampling techniques to be used in hyporheic habitats.

2.5 Primary Headwater Habitat (PHWH) Stream Evaluation (stream less than 1.0 mi^2 (259 ha) and deep pools less than 40 cm)

If the watershed size is less than 1.0 mi^2 (259 ha), and deep pools are less than 40 cm, a primary headwater habitat stream evaluation must be completed. A copy of the form to be used to record data is provided in Attachment 1, and is herein referred to as the "PHWH Form". This section of the manual provides instructions for collecting the essential data needed to complete the PHWH Form. The PHWH Form is to be used to record all field measures and observations for physical (i.e., HHEI), and biological assessments. The PHWH Form is divided into four (4) pages. Detailed instructions for completion of each page follows:

PHWH FORM - PAGE 1

2.5.1 General Stream Information

Provide the site descriptive information as requested on the top of the first page of the PHWH Form. Information should be provided with enough specifics to allow for return visits to the same location. Observations on landmarks, etc. are important in order to re-locate the site at a later time. The river basin represents the major basin in the stream network that the PHWH stream ultimately flows into. River code information specific to the Ohio EPA data tracking system and can be left blank.

Using either a 7.5 minute series USGS topographic map, or a NRCS county soil map, determine the upstream drainage area for the PHWH stream segment under investigation. It is likely that small headwater streams will not be identified at the USGS 1:24,000 mapping scale, in which case it will be necessary to determine stream length by connecting elevation contour lines. Record the date of the assessment and the name of the scorer in the space provided at the top of the PHWH Form.

If a GPS unit is not available, latitude and longitude should be estimated from a 7.5 min. series USGS topographic map in minutes-degrees-seconds, or from one of the free internet based topographic mapping sites such as http://www.topozone.com. Measure the lat/long reading from the center of the 200 ft reach.

2.5.2 Determination of Channel Modification

The PHWH field evaluation process for a stream reach begins with a determination of whether or not the stream channel has been modified by channelization. A determination must be made as to the extent the channel geomorphology has been modified and sinuosity reduced. The following terms are used to determine the extend of channel modification:

Channelization: [(1) none, (2) recovered, (3) recovering, (4) recent or no recovery]

On the front of the PHWH Form, determine the proper level of channel modification and record in the space provided next to the heading "Stream Channel Modifications". In general, evidence of recent or recovering channels would include low sinuosity, entrenchment, no flood plain, the absence of or poorly developed point bars, poor or no pool riffle-run-pool development, high width/depth ratio, and highly embedded substrates. Streams judged to be (3) or (4) above are considered "modified streams" for purposes of the HHEI flow chart on page 23, Figure 7.

2.5.3 Calculation of the Headwater Habitat Evaluation Index (HHEI)

The HHEI is a multi-parameter rapid assessment of the physical habitat that can be used to predict the biological *potential* of most PHWH streams. The HHEI is calibrated to streams with watershed size between 0.1 to 1.0 mi^2, that have deep pools of water less than 40.0 cm., and should only be used within these watershed size limitations. All HHEI measurements are to be made within the 200 ft (61 m) stream reach zone. On the front of the PHWH Form, within the large box, are three field measurements that must be taken to calculate a final Headwater Habitat Evaluation Index (HHEI) score. Information obtained from the HHEI scoring is then used to determine the biological *potential* of the PHWH stream following the HHEI decision making flowchart in Figure 7, page 23.

HHEI Metric # 1: Stream Channel Substrate

Next to an adequate supply of water, the kind of substrate found in the stream channel is likely to be the most important feature that predicts biological potential. Acting in conjunction with other physical characteristics of the stream channel, the composition of the substrate will determine how the stream exports sediment to downstream water bodies, and the type of biology present. Class III-PHWH fauna are seldom found in streams dominated by fine grained or monotonous substrate types. This metric does a good job of separating Class III-PHWH streams from all other types of headwater streams.

The characterization of the channel substrate shall include an visual assessment of the 200 ft (61 m) stream reach using a reasonably detailed evaluation of both the dominant types of substrate, and the total number of substrate types. Record the presence and percentage (%) of the two most dominant substrate types found in the stream reach, and the presence and percentage (%) of all minor substrate types observed. **Exact information on substrate percentage (%) is required in order to complete the HHEI decision flowchart found in Figure 7, page 23.** Record the substrate data on the front of the PHWH Form in the spaces provided.

Although not required, a pebble-count method can be used to quantify the percentages of the most common substrate types. A minimum number of 100 records should be used when conducting a pebble-count in a PHWH stream. Pebble-count data can be recorded on the field form provided in Attachment 4. Notes should be made of any substrate types visually present that are not identified using the pebble-count method. (See Ohio EPA, 1999 Draft Fact Sheet 1-MAS-99 for details on how to conduct a pebble-count.)

A summary of definitions for the nine major substrate types that apply to the HHEI evaluation follows:

- ❑ **Bedrock Substrates:**

  Streambed characterized by the presence of monolithic bedrock outcropping. May be fractured, and often associated with boulder and cobble substrates. Since PHWH streams with bedrock substrate are often associated with the surface discharge of groundwater, a high degree of association was found at these sites with the presence of cool-cold water native fauna of obligate salamanders and benthic macroinvertebrates.

- ❑ **Boulder Substrates:**

  These substrate types provide excellent habitat for obligate aquatic salamanders, fish, and benthic macroinvertebrates because of their inherent stability. They are separated into two types:

  - ❒ **Boulder Slabs:**

    Greater than 256 mm, flat instead of round (ratio of 1^{st} to 2^{nd} longest dimensions >2).

  - ❒ **Boulders:**

    Greater than 256 mm, round, above ratio <2.

- ❑ **Cobble Substrates:**

  Stones greater than 64 mm but less than 256 mm. This substrate type has a strong association with Class III-PHWH streams.

- ❑ **Gravel Substrates:**

  Particles 64 mm or less, but at least 2 mm in size. This substrate type is neutral in its ability to separate the three classes of PHWH streams, but is often a secondary component of Class III PHWH streams.

- ❑ **Sand Substrates:**

  Particles less than 2 mm in size, gritty texture when rubbed between fingers. This substrate type is often a secondary component of Class III-PHWH streams.

❑ **Silt Substrates:**

Particles less than 2 mm in size, greasy texture when rubbed between fingers. Silt is most often a conglomerate of eroded clays and very fine organic matter which has deposited in the stream channel. There is a negative association of silt with Class III-PHWH streams, but silts can be present in limited amounts in natural channels with low energy dynamics.

❑ **Clay or Hardpan Substrates**:

This substrate type is typically found when the stream bed has eroded to a depositional clay layer within the underlying sub-soil. This substrate is typically hard and gummy and is difficult to penetrate. Unlike silts, this substrate type is not deposited in the stream channel by recent fluvial processes. It provides a poor habitat for most native fauna.

❑ **Muck Substrate:**

Decayed organic matter with little or no clay content. Differs from silt by being almost entirely organic in nature, less dense, and more odorous. This substrate type is neutral in its ability to separate the three classes of PHWH streams.

❑ **Detritus Substrates:**

Detritus refers to the presence of partially or undecayed sticks, wood, leaves or other plant material deposited in the stream channel. The allochthonous input of organic matter is the primary energy resource for the biological community of PHWH streams. Two categories are recognized:

❒ **Leaf Pack/Woody Debris**:

The presence of leaf packs and wood provides for an energy resource as well as habitat for colonization of plants and animals. Although this substrate type was found to be neutral in its ability to separate the three classes of PHWH streams, it is often found as a secondary component of Class III-PHWH streams with heterogenous substrates. It provides potential microhabitat and food source for benthic macroinvertebrates that are prey for fish and obligate aquatic salamanders. This substrate type is also positively associated with the presence of salamander larvae.

❒ **Fine Detritus:**

This substrate type refers to fine, partially decomposed plant material which has accumulated within the stream channel as a precursor to the development of a muck deposits. These materials are subject primarily to microbial decomposition processes. Fine particular organic matter may be correlated with the presence of macroinvertebrate fauna that "collect" fine organic matter as a food source.

HHEI Metric #2. Maximum Pool Depth

The maximum pool depth within the stream reach is important since it is a key indicator of whether the stream can support a well balanced fish community. Streams with pools less than 40 cm in depth are less likely to have well balanced WWH fish communities (Rankin, 1989, Figure 16), and thus more likely to have dense populations of lungless salamanders. Maximum pool depth is also related to the type of flow present in the stream channel (i.e., continuous, intermittent, interstitial), and thus serves as a good discriminator of the various classes of PHWH streams. Search the entire 200 ft (61 m) stream reach and record the maximum pool depth observed. Measurement should be to the nearest centimeter.

HHEI Metric # 3. Average Bank Full Width

Bankfull width is a morphological characteristic of small streams directly related to energy dynamics that can affect biological communities. It has been found to be a strong discriminator of the three types of PHWH streams in Ohio. The bankfull width of a stream channel should be measured in riffle areas (or in a glide/ run in the absence of riffles). A relatively straight stream segment should be selected which is not affected by the deposition of debris. The bankfull width has been defined as:

> *" ... the discharge at which channel maintenance is the most effective, that is, the discharge at which moving sediment, forming or removing bars, forming or changing bends and meanders, and generally doing work that results in the average morphologic characteristics of channels."* Dunne and Leopold (1978). Rosgen (1996) gives several suggestions for determining bankfull width in streams:
>
> i. *"A break in slope of the banks and/or a change in the particle size distribution (since finer material is associated with deposition by overflow, rather than the deposition of coarser material within the active channel)."*
>
> ii. *"Evidence of an innundation feature such as small benches."*
>
> iii. *"Staining of rocks."*
>
> iv. *"Exposed root hairs below an intact soil layer indicating exposure to erosive flow."*

The boundary line where terrestrial vegetation begins along the stream margin can also indicate the edge of the bankfull width (Figure 6). Although caution must be taken under drought conditions, this is an excellent feature to use in combination with other indicators mentioned above for headwater streams. Often it will be possible to determine the bankfull stage on only one bank of the stream.

Once there is confidence in the bankfull boundary, stake the measuring string at that point, and use the following procedure to determine the Bank Full Width HHEI metric (see Figure 6).

1. Place bubble type line level on measuring string.
2. Suspend the measuring string perpendicular to the stream flow from the staked location to the opposite bank.
3. Pull string taunt and manipulate up and down until the line level indicates that the string is level. Mark the location where the string intersects the opposite bank.
4. Measure the distance between the marked bankfull locations on either bank of the stream.
5. Take 3-4 measures throughout the 200 ft (61 m) stream reach and calculate an average Bank Full Width for the stream segment. Record result on the PHWH Form in the space provided.

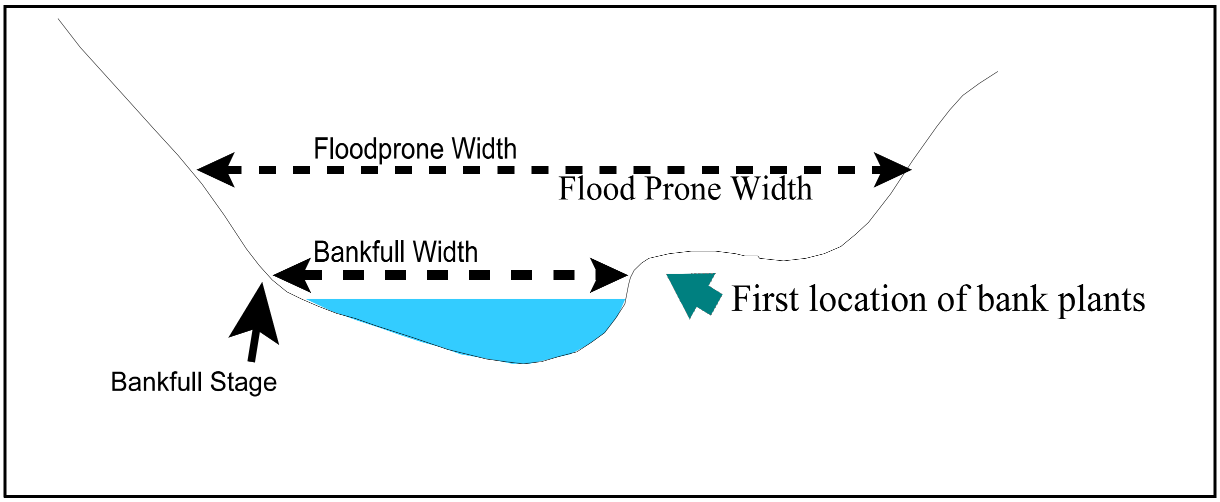

Figure 6. Graphic representation of the Bank Full Width metric required for the HHEI evaluation. Take 3-4 measures in the 200 ft stream reach and calculate an average score. Flood Prone Width is measured at a distance 2x the height of the water surface at Bankfull Width.

2.5.3b Using the HHEI Assessment to Assign Existing Aquatic Life Use Potential

The Ohio EPA currently uses a rapid habitat assessment tool, the QHEI, to assess the biological *potential* of larger streams in Ohio. As a rule of thumb, if multiple QHEI assessments along a stream corridor have an average QHEI score greater than 60 points, this information can be used to assign a Warmwater Habitat (WWH) aquatic life use designation to an undesignated stream with deep pools greater than 40 cm (see Figures 15 and 16 in Rankin, 1989). However, a QHEI less than 60 points does not necessarily suggest that a WWH use cannot be obtained, unless the QHEI score is significantly degraded due to a high number of modified metrics (see Rankin, 1989 for guidance).

In a manner similar to use of the QHEI, it is possible to use the HHEI to determine the biological *potential* of PHWH streams in Ohio. Whereas the QHEI is calibrated to the presence of a well balanced fish assemblage, the HHEI is calibrated to the presence-absence of salamanders species with multi-year larval periods, which can replace fish as the top vertebrate predator in headwater streams. Neither the QHEI nor the HHEI are primarily calibrated to the presence or absence of well balanced benthic macroinvertebrate communities, although the HHEI can be used to predict the presence of cool water adapted species of macroinvertebrates where they are strongly associated with salamander larvae.

The decision making flowchart found in Figure 7 must be used to assign an appropriate existing aquatic life use to an unnamed PHWH stream based on a HHEI evaluation. This flowchart allows for both natural and modified PHWH stream channels to be placed into one of three potential PHWH stream types (Class I, II, and III). When the results of both a biological assessment and a HHEI assessment are available, the data from the biological assessment will be used to assign an existing aquatic life use to the PHWH stream, unless there is reason to suspect that chemical toxicity is limiting the full biological potential of the stream. If toxicity is present, the HHEI assessment can be used to determine the *potential* aquatic life use that would be present if the chemical toxicity was eliminated. A similar approach is used in larger streams with the QHEI evaluation, which is used by Ohio EPA to determine if a stream has potential to attain a Warmwater Habitat fish community in the absence of chemical toxicity. Chemical-physical parameters that could affect headwater stream biology include ammonia-N, low dissolved oxygen, excessive siltation, heavy metals from mine drainage, pH, and excessive increase in water temperature.

2.5.4 Riparian Zone and Flood Plain Quality

The riparian ecotone between the flowing water of the stream and the adjacent flood plain is a critical habitat for the fauna that lives in primary headwater streams. This habitat provides the primary source of food in the form of fallen leaves (detritus) for the benthic macroinvertebrate food web. Physical structure in the form of leaf litter and decayed logs provide shelter for amphibians and other animals. The shading provided by a well formed canopy of vegetation helps to maintain cool water temperatures in the summer months in cold-cool Class III-PHWH corridors. The riparian zone is also an important migratory corridor for many forms of wildlife including mammals, reptiles, amphibians, and birds.

The amount of open area in the tree canopy should be estimated as that which would be experienced at the time of maximum leaf cover. This information can be useful for making a final determination of the appropriate use designation for the PHWH stream under investigation. The Riparian Width metric on the PHWH Form is completed by checking the appropriate selection for the riparian width <u>for each bank</u>. River right and river left are determined as looking downstream. In cases where the riparian width varies significantly within the stream reach being evaluated, the two most appropriate selections should be checked. It may also be of interest to record the type of plant community found in the riparian corridor of the stream reach under investigation. This information should be recorded in the comments section.

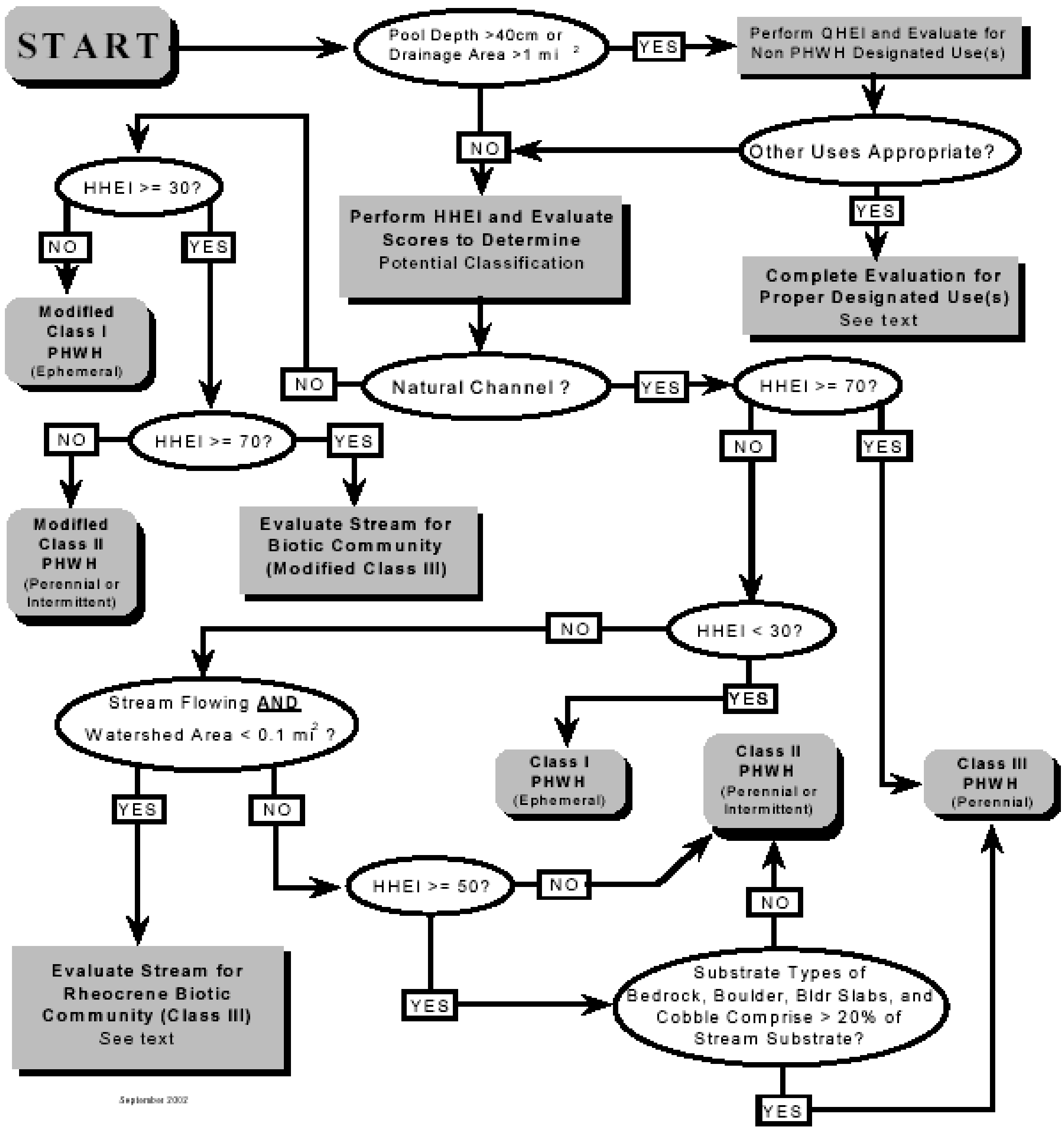

Figure 7. Decision making flowchart to determine appropriate PHWH stream class using the Headwater Habitat Evaluation Index (HHEI) protocol

2.5.5 Flow Regime

The following definitions shall apply for apparent flow characteristics:

Stream Flowing : Flowing water present at time of assessment.

Interstitial Flow with Isolated Pools: Flowing water present in isolated pools, which remain connected by subsurface flows. Dye testing may be needed to document pool connection.

Moist Channel, Isolated Pools, No Flow: Moist substrate and/or water present in isolated pools, but no visual evidence that the water in the pools is flowing.

Dry Channel, No Water: A completely dry channel for the entire 200 ft (61 m) stream reach.

Record the appropriate flow condition at the time of evaluation in the space provided on the PHWH Form. This information can be very useful in making a final use designation decision. If it is believed that low flow conditions would be significantly different than that observed at the time of the evaluation, this can be confirmed by either waiting until the stream is at seasonal low flow conditions, or by conducting a biological evaluation of the stream.

2.5.6 Sinuosity

Although not determined to be a significant discriminator of PHWH stream types, the sinuosity of a stream is related to channel modification, which is one of the primary factors used in the HHEI assessment flowchart to assign a final use designation (Figure 7, page 23). Determine the number of complete well-defined outside bends in the 200 ft (61 m) stream reach and record on the PHWH Form. This method of estimating sinuosity differs from the more quantitative technique of Rosgen (1996), which is based on the ratio of the channel length to valley length to define a unit-less sinuosity coefficient (K).

2.5.7 Stream Gradient

Although gradient was determined not to be a significant discriminator of PHWH stream class, gradient was found suitable for separating Class III-PHWH streams from all other types. In general, Class III-PHWH streams tend to have moderate gradient (about 0.02 feet/foot) and rarely greater than 0.10 feet/foot drop. Both very high gradient streams and sluggish streams do not provide optimal flow hydrology for the types of biological communities adapted for life in Class III-PHWH streams. On the front of the PHWH Form, check the box with the best visual estimate of stream gradient for the stream reach.

PHWH FORM - PAGE 2

Check the appropriate box as to whether or not a QHEI evaluation was performed. If yes, attach a copy of the final QHEI sheet.

2.5.8 Downstream Designated Uses(s)

If known, mark the box which indicates the appropriate downstream (within two river miles) designated uses. Check a box only if the stream segment feeds to a wetland or to a stream with a known use designation. If the downstream segments are un-designated, check no boxes, but describe downstream characteristics in the space provided.

Please be specific in responses to this item! Information provided in this section will be used to evaluate potential beneficial uses of the water body and to evaluate potential impacts on downstream uses. A description of the drainage hierarchy downstream of the segment being analyzed to the nearest named stream should be provided if possible.

Attach a copy of both the USGS topographic map and the NRCS county soil map with the watershed areas of the PHWH streams clearly identified.

2.5.9 Miscellaneous

2.5.9 (a) Water Chemistry

If necessary, conduct field measurements for dissolved oxygen, pH, water temperature, and conductivity using standard Ohio EPA quality control methods (1997, as updated). Temperature in summer months can be used to verify potential cool-cold water Class III-PHWH streams. In general, Class III-PHWH streams will have <u>daily average</u> summer water temperature below 20 ^{0} C , with values less than 18 ^{0} C near the spring source. Class III-PHWH well away from their spring source(s) can have <u>daily maximum</u> summer water temperature higher than 20 ^{0} C, but rarely above 23 ^{0} C (see Ohio EPA 2002b technical report).

Water samples for the analysis of other parameters normally will not be collected. However, in the event that upstream chemical pollution of the water is suspected, a sample should be collected for analysis in order to ensure that site biology is not affected by water chemistry. If a sample is collected, provide the sample identification information and provide copies of the analytical report. In general, under these circumstances, analyses should be conducted for nutrient parameters (ammonia-N, nitrate+nitrite-N, total phosphorus), COD, chlorides, heavy metals, and fecal coliform bacteria. Where acid mine drainage is suspected include samples for iron, manganese, and sulfates.

2.5.9 (b) Biological Evaluation Summary

If a biological evaluation is conducted, complete the information in this section of the form as indicated. A detailed summary of biological data should be recorded on pages 3 and 4 of the PHWH Form.

2.5.10 Drawing and Narrative Description of the PHWH Stream Reach

In the space provided on the form, make a drawing of the evaluated PHWH stream reach, with important landmarks and other features of interest. Include any road crossings. The drawing should include comments on the type of riparian zone and land use adjacent to the stream reach, and any observations on seepage areas.

PHWH FORM - PAGE 3 and 4

2.5.11 Biological Sampling

All data collected for biological assessments should be recorded on pages 3 and 4 of the PHWH Form. The following sections provide information on the standardized methods to be used to collect and preserve biological specimens.

2.5.11 (a) Headwater Fish

Many primary PHWH streams less than 1.0 mi^2 (259 ha) contain fish species that are classified by Ohio EPA (1989) into one of three major categories: (1) cold water adapted (e.g., central mottled sculpin); (2) pioneering (e.g., creek chub), or (3) headwater adapted (e.g., blacknose dace). All three types of headwater fish species have been collected in PHWH streams less than 1.0 mi^2 . A list of all species of fish collected from PHWH in 1999 and 2000 is provided in Table 3. The Creek Chub was the most common species, collected in 32.8 % of all samples, with Bluntnose Minnow (19.4 %), and Blacknose Dace (10.4 %) next in frequency of occurrence.

Although many different species of fish are present in PHWH streams as shown in Table 3, it becomes increasing less likely than a <u>well balanced</u> fish community will be present, as measured by the Index of Biotic Integrity (IBI), as watershed size falls below 1.0 mi^2 (259 ha). Fish are more likely to move out of temporary flow conditions that are found in PHWH streams. There exists in natural watersheds a zone of demarcation where fish are no longer observed, but are replaced by amphibious salamanders (see Figure 1). The presence of cool-cold water fish species from Table 3 can be used to identify the presence of a Class III-PHWH stream. A Class II-PHWH stream is indicated by the presence of warmwater adapted populations of fish.

Sampling methods to collect fish in PHWH streams can include either electro-fishing techniques (i.e., long-line or backpack methods), 10 ft seine, or fine mesh benthic invertebrate net. If assessing the stream for potential WWH or EWH use designation, standard procedures using electrofishing techniques must be followed (Ohio EPA, 1989).

For a PHWH stream survey, fish must be collected for at least 15 minutes through the 200 ft (61 m) stream reach under investigation. Record all species collected and their total numbers on the HHEI field form. Voucher specimens should be collected for each species and preserved in a solution consisting of one part buffered formalin and nine parts water. If voucher specimens are to be held longer than 2-3 weeks, the specimens should be transferred to an 70% ETOH preservative using the methods described in the Ohio EPA methods manual (Ohio EPA, 1989). Place a field tag in/on the jar which includes date, collector name, county, township, and stream identification as listed on the HHEI field evaluation form. Record in minutes the total time spent searching for fish. If there are deep pools present that are greater than 40 cm maximum depth, then the Ohio EPA QHEI habitat evaluation should be conducted, and the stream evaluated for potential to attain the Ohio EPA Warm Water Habitat (WWH) or Exceptional Warmwater Habitat use designations according to established agency procedures (Rankin, 1989). The presence of cold water fish would trigger the Cold Water Habitat (CWH) designation.

Table 3. Table of fish species observed/collected in primary headwater habitat streams in Ohio, 1999 and 2000. Total of 67 streams sampled. Fish species in **bold** represent PHWH stream indicator species based on habitat preference. Fish in *italics* indicate cold water adapted Class III-PHWH indicator species. <u>Yes</u> indicates species associated with listed ecological category in Ohio EPA (1989); <u>No</u> indicates species not associated with that category.

Species (common name)	Percent (%) Occurrence	Pioneering Species	IBI-Headwater Species	Coldwater Species
creek chub	**(32.8)**	**Yes**	**No**	**No**
bluntnose minnow	**(19.4)**	**Yes**	**No**	**No**
blacknose dace	**(10.4)**	**No**	**Yes**	**No**
rainbow darter (7.5)	No	No	No	No
bluegill sunfish (4.5)	No	No	No	No
johnny darter (4.5)	**Yes**	**No**	**No**	No
stoneroller minnow	(4.5)	No	No	No
largemouth bass	(2.9)	No	No	No
fantail darter (2.9)	**No**	**Yes**	**No**	No
greenside darter	(2.9)	No	No	No
white sucker	(2.9)	No	No	No
green sunfish (2.9)	**Yes**	**No**	**No**	No
redside dace	***(1.5)***	***No***	***Yes***	***Yes***
mottled sculpin	***(1.5)***	***No***	***Yes***	***Yes***
native brook trout	***(1.5)***	***No***	***No***	***Yes***
rainbow trout**	(1.5)	No	No	Yes
goldfish**	(1.5)	No	No	No
mudminnow	(1.5)	No	No	No
orangethroat darter	**(1.5)**	**Yes**	**No**	**No**

Fish species expected to occur in PHWH streams but not observed during 1999 and 2000 surveys.

creek chubsucker	—	**Yes**	**No**	**No**
southern redbelly dace	—	**No**	**Yes**	**No**
rosyside dace	—	**No**	**Yes**	**No**
silverjaw minnow	—	**Yes**	**No**	**No**
fathead minnow	—	**Yes**	**No**	**No**
brook stickleback	—	***No***	***Yes***	***Yes***
brown trout**	—	No	No	Yes

** = Non-Native Species

2.5.11 (b) Headwater Salamanders

In the headwaters of watersheds, aquatic to semi-aquatic salamander species replace fish as the primary vertebrate predator functional group. These amphibians are distributed throughout Ohio except for the counties in the northwest area of the state. Detailed maps for the distribution of salamanders in Ohio by county are given in Pfingsten and Downs (1989) and Pfingsten (1998). Because salamanders are most active during the night in response to predation by other vertebrates, they are found during the daylight hours hiding under different types of microhabitat cover including rocks, logs, leaves, moss, bark, burrows, etc. Thus any attempt to collect salamanders along a stream corridor must include an effort to sample all the different types of microhabitat cover available in the stream reach under investigation

Based on the results of the 1999 and 2000 sampling, three assemblages of salamander species have been identified from PHWH streams throughout the state, which are summarized in Table 4 & 5, and discussed in detail below:

Class III-PHWH Salamander Assemblage (perennial cool water flow adapted; larvae present in stream on annual basis, with greater than 12 month larval period)

This salamander assemblage is represented by species of <u>obligate</u> aquatic species that have larvae resident in the stream channel on an annual basis. Most of these species have larval stages that last for at least two years in Ohio based on literature available, with a maximum span between 4-5 years (Petranka, 1998; Pfingsten and Downs, 1989; observations of R. D. Davic, Ohio EPA). The exception is the Longtail salamander, *Eurycea longicauda*, which may or may not have a larval period greater than 12 months in Ohio. Class III species also require flowing water for egg deposition, with females usually laying eggs in habitats saturated with flowing water, often under rocks. Salamander species associated with Class III-PHWH streams in Ohio are taxonomically related, all classified within the Tribe Hemidactyliini, Subfamily Plethodontinae, of the Family Plethodontidae. Eight species or subspecies from the genera *Eurycea*, *Gyrinophilus*, and *Pseudotriton* are recognized for Ohio (Table 4). Two of these species, the cave salamander (*Eurycea lucifuga*), and the midland mud salamander (*Pseudotriton montanus diasticus*) are listed as "endangered" and "special interest", respectively, in ORC 1531.25. The two species of the two-lined salamander (*Eurycea spp*.) were the most common salamanders collected during the 1999 to 2001 survey. The presence of Class III salamander species in PHWH streams is highly associated with the presence of cool water adapted species of benthic macroinvertebrates.

Class II-PHWH Salamander Assemblage (intermittent to constant warm water flow adapted; larvae present in the stream seasonally, less than 12 month larval period)

The second assemblage of salamanders found in PHWH streams in Ohio are associated with a continuum of permanent to intermittent flow conditions, and are distinguished from the obligate aquatic assemblage of salamanders by having a larval period less than 12 months. These <u>non-obligate</u> aquatic salamander species are taxonomically different from the obligate salamander assemblage, being classified within the Subfamily Desmognathinae of the Family Plethodontidae, the Family Ambystomatidae, and the rarely encountered species *Hemidactylium scutatum* (four-toed salamander). Although salamanders from this non-obligate group may be found coexisting with obligate Class III salamander species, these <u>non-obligate</u>

aquatic species have life history traits that do not require residence in flowing water on an annual basis. Salamanders in Ohio from the genus *Desmognathus* do not require flowing water for egg clutch deposition, but instead lay eggs in streambank habitats, usually under rocks, moss, or logs; although seepage areas may also be utilized. Species from the genus *Ambystoma*, which may lay eggs within the flowing water of a PHWH stream channel, have short larval periods. They tend to be found in streams that become intermittent or completely dry during summer months. A third aquatic salamander genus, *Hemidactylium*, is largely found in sphagnum bogs, but may migrate to headwater streams that connect to these bogs. The presence of species of salamanders from this non-obligate aquatic assemblage can be used to identify the presence of a warmwater Class II-PHWH stream types. Two species from this second group, the blue-spotted salamander (*Ambystoma laterale*) and the four-toed salamander (*Hemidactylium scutatum*), are listed as "endangered" and "special interest", respectively, in ORC 1531:25.

Class I -PHWH Salamander assemblage (adapted for life in terrestrial forest habitat, no aquatic larvae stage of development, may forage in dry channels in search of food).

A third assemblage of salamander species that may on occasion migrate into small PHWH stream corridors, usually during wet periods, include species from the genera *Plethodon* and *Aneides*. These salamander species have terrestrial modes of existence and lack larval stages, but they are an important component of the food web structure of second growth forests in Ohio. *Plethodon* species are good bio-indicators of various stages of forest succession, with preference for old growth forest seral stages. They are common in beech-maple associations that once were dominant throughout Ohio. *Plethodon* salamanders live in burrows and under decaying logs and leaf litter in forested areas throughout the state. They may forage in dry Class I PHWH stream channels in search of food.

2.5.11 (b) (1) Salamander Sampling Effort

The goal of the PHWH stream salamander evaluation is to document the presence-absence of species from the three major eco-hydrologic groups discussed above. The technique used is a modification of a Visual Encounter Survey (VES) as described by Heyer, et al.(1994). Although a VES survey is semi-quantitative, more vigorous sampling techniques can be utilized to quantify salamander densities if required. Examples include the 4 m^2 quantitative sampling method as described by Rocco and Brooks (2000), or the placement of artificial substrates such as flat boards or leaf bags (see Pauley and Little, 1998, for leaf bag method). These types of quantitative estimates of salamander abundance have not been calibrated for this PHWH manual.

Begin the salamander Visual Encounter Survey (VES) by selecting **TWO** 30 ft (9.1 m) sections of stream within the 200 ft (61 m) stream reach under investigation. Choose each sample zone where an optimal number and size of cobble type microhabitat substrate is present (64 to 128 mm length), even over bedrock. This substrate size class has been shown to be a good predictor of the presence of obligate aquatic salamander species. If both salamander and benthic invertebrate sampling is to be conducted at the same time by two people, place the salamander sample zones upstream from the initial macro-invertebrate survey to eliminate problems with water turbidity caused by kick net sampling. <u>If no salamanders are observed in the first 30 ft (9.1 m) sample zone, repeat the process for the second zone.</u>

Table 4. Species of salamanders that can be used as bio-indicators of Class III (cool-cold water, perennial flow) and Class II (warmwater, intermittent flow) PHWH streams in Ohio.

Species Adapted to Perennial Flow, with Larval Periods > 12 months (Class III-PHWH Indicators)

Family Plethodontidae (Lungless Salamanders)

Subfamily Plethodontinae; Tribe Hemidactyliini

Eurycea bislineata bislineata (northern two-lined salamander)

Eurycea bislineata cirrigera (southern two-lined salamander)

Eurycea longicauda (long-tailed salamander) [Some populations may have short larval periods.]

Eurycea lucifuga (cave salamander)**

Gyrinophilus porphyriticus porphyriticus (northern spring salamander)

Gyrinophilus porphyriticus duryi (Kentucky spring salamander)

Pseudotriton montanus diasticus (midland mud salamander)**

Pseudotriton ruber ruber (northern red salamander)

Species Adapted to Survive Intermittent Flow, with Larval Periods < 12 months (Class II-PHWH Indicators)

Family Ambystomatidae (Mole Salamanders)

Ambystoma barbouri (stream side salamander)

Other *Ambystoma spp*. (Such as smallmouth salamander, tiger salamander)

Family Plethodontidae (Lungless Salamanders)

Subfamily Desmognathinae

Desmognathus fuscus fuscus (northern dusky salamander)

Desmognathus ochrophaeus (mountain dusky salamander)

Subfamily Plethodontinae; Tribe Hemidactyliini

Hemidactylium scutatum (four-toed Salamander)** [This species not common in headwater streams.]

** Note: The salamander species, *Eurycea luifuga* (cave salamander), *Ambystoma laterale* (blue-spotted salamander), *and Aneides aeneus* (green salamander) are listed as "endangered" species in Ohio (ORC 1531:25). The species *Hemidactylium scutatum* (four-toed salamander), and *Pseudotriton montanus diasticus* (midland mud salamander) are listed as "special interest" in ORC 1531:25.

Adapted from "Salamanders of the United States and Canada", 1998. James W. Petranka. Smithsonian Institution Press, Washington, DC.

Table 5. List of salamander species in Ohio that use primary headwater stream corridors as a habitat for egg deposition (oviposition) and larval growth. Species ordered from shortest length of larval period to longest. Life history data from personal observations of R.D. Davic (Ohio EPA), Harding (1997), Pfingsten and Downs (1989), Petranka (1998), Hulse et al.(2001). *Plethodon* and *Aneides* species with direct development not included in the table. When multiple species are collected in the same stream segment, the species with the highest numerical classification is used to indicate potential appropriate PHWH stream class (I, II, or III). **Only evidence of reproduction (larvae, eggs, or mixture of juveniles and adults) can be used to determine stream class.** Table by R. D. Davic, Ohio EPA.

Species	**Microhabitat and Season for Egg Clutch Deposition+ <u>PHWH Stream Class Indicator Type</u>.**	**Length/Season of Larval period.**
Four-toed salamander (*Hemidactylium scutatum*)	Statewide. Found in bog habitats, eggs usually found in moss (sphagnum) from March to May. Eggs may be found in slow moving headwater streams associated with bog habitat. Adults terrestrial. <u>If evidence of reproduction found, a Class-II PHWH stream indicator species</u>. Protected as a Special Interest species in ORC, Section 1531.25.	1-2 months (May to June). Pond type larval
Streamside salamander (*Ambystoma barbouri)*	SW Ohio only. Oviposition from January to March in headwater streams with few fish. Stream usually becomes intermittent during summer. Often in limestone type geology. Eggs found in water under rocks between December to March. <u>If evidence of reproduction found, a Class II-PHWH stream indicator species</u>.	2-3 months (March to May).
Mountain dusky salamander (*Desmognathus ochrophaeus*)	Extreme NE Ohio only. Oviposition near seepage areas, mostly from August to October. Known to breed in sub-surface habitats. Stream may become intermittent in summer. Adults will forage in riparian areas. <u>If evidence of reproduction found , a Class II-PHWH stream indicator species</u>.	1-3 months. Most common in September to November, but may occur in March-April in some Ohio populations.
Northern longtail salamander (*Eurycea longicauda)*	Statewide except northwest and north-central Ohio. Oviposition over winter in streams and seepage areas associated with rock outcrops or in sub-surface areas. Often in limestone or shale geology, around caves. <u>If evidence of reproduction found, a Class II-PHWH stream indicator species.</u> <u>If 2 larval age classes present, then a Class III indicator.</u>	4-5 months, (March to July), but may extend to 12-14 months in local populations. Larval period not well known for Ohio.

Table 5 continued. List of salamander species in Ohio that use primary headwater stream corridors as a habitat for egg deposition (oviposition) and larval growth Species ordered from shortest length of larval period to longest. Life history data from personal observations of R.D. Davic (Ohio EPA), Harding (1997), Pfingsten and Downs (1989), Petranka (1998), Hulse et al.(2001). *Plethodon* and *Aneides* species with direct development not included in the table. When multiple species are found in the same stream segment, the species with the highest numerical classification is used to indicate appropriate PHWH stream class (I, II, or III). **Only evidence of reproduction (larvae, eggs, or mixture of juveniles and adults) can be used to determine stream class**. Table by R. D. Davic, Ohio EPA.

Species	**Microhabitat and Season for Egg Clutch Deposition+ PHWH Stream Class Indicator Type.**	**Length/Season of Larval period.**
Northern dusky salamander (*Desmognathus f. fuscus*)	Statewide except northwest and north-central Ohio. Oviposition in streambank microhabitats or seepage areas, outside flowing water (June to August). Eggs not in flowing water, but streamside under rocks, logs, moss with brooding female. If evidence of reproduction found, a Class II-PHWH stream indicator species. May be found in Class III stream habitats.	9-10 months (September to May). No larvae in June and July. Young and old larvae may be found in streambank outside flowing water
Cave salamander (*Eurycea lucifuga*)	Extreme southwest counties of Ohio, at northern edge of geographic range. Oviposition from September to February within caves. If evidence of reproduction found, a Class III-PHWH stream indicator species. Very rare, classified as an Endangered Species in Ohio (ORC 1531.25).	Mostly 14-18 months with two larval age classes common in Indiana populations. Larval period not well known for Ohio.
Midland mud salamander (*Pseudotriton montanus diasticus*)	Extreme south central Ohio. Oviposition in autumn, embryos hatch in winter. Common in burrows; egg nests in cryptic underground sites. If evidence of reproduction found a Class III PHWH stream indicator species.	15 to 30 months, larval period not well known for Ohio populations.
Northern two-lined salamander (*Eurycea bislineata*)	North Central to North East Ohio. Common in perennial flowing PHWH streams. Oviposition from April to May, in shallow running water under flat rocks. May be found in dry streams with interstitial sub-surface flow. If evidence of reproduction found, a Class III PHWH stream indicator species. Known to migrate into higher order streams.	24 to 36 months in Ohio. Three distinct larval age classes observed in some populations.

Table 5 continued. List of salamander species in Ohio that use primary headwater stream corridors as a habitat for egg deposition (oviposition) and larval growth Species ordered from shortest length of larval period to longest. Life history data from personal observations of R.D. Davic (Ohio EPA), Harding (1997), Pfingsten and Downs (1989), Petranka (1998), Hulse et al.(2001). *Plethodon* and *Aneides* species with direct development not included in the table. When multiple species are found in the same stream segment, the species with the highest numerical classification is used to indicate appropriate PHWH stream class (I, II, or III). **Only evidence of reproduction (larvae, eggs, or mixture of juveniles and adults) can be used to determine stream class.** Table by R. D. Davic, Ohio EPA.

Species	**Microhabitat and Season for Egg Clutch Deposition+ PHWH Stream Class Indicator Type.**	**Length/Season of Larval period.**
Southern two-lined salamander (*Eurycea cirrigera*)	Southern portion of Ohio, considered a sub-species of *E. bislineata* by Petranka (1998). Same behavior as northern two-lined salamander. If evidence of reproduction found, a Class III-PHWH stream indicator species.	24 to 36 months in Ohio. Three distinct larval age classes in summer
Red salamander (*Pseudotriton ruber*)	Eastern portions of state, north to south. Oviposition from October to February, usually in sub-surface areas. Adults migrate away from streams in spring-summer, but overwinter in headwater springs. Associated with sandstone geology. If evidence of reproduction found, a Class III-PHWH stream indicator species.	24 to 36 months, may overwinter to a fourth year as larvae.
Spring salamander complex (*Gyrinophilus p. porphyriticus,* and *G. p. duryi*.	East to east-central and southern portions of the state. Oviposition in summer months, in sub-surface areas. Adults may forage away from streams, they have a propensity for a subterranean mode of life in cold-cool headwater springs. May be associated with caves. If evidence of reproduction found, a Class III-PHWH stream indicator species.	36 to > 48 months.

An ordinary metal strainer, bent to a triangular shape, or a fine mesh aquatic invertebrate net is recommended to collect salamanders, especially the small slippery and elusive larvae. Small aquaria nets and flat edge insect nets can also be used. Gilled, premetamorphic larvae are usually restricted to the flowing water of the stream, although Dusky salamander larvae have been observed out of flowing water in moist sand-gravel substrate (R. D. Davic, personal observation). Salamanders, especially larvae, are often found hiding under cover objects such as rocks, leaves, and woody material as a protection from possible predators.

As you move upstream, first place the net against the bottom substrate and then lift cover objects in front of the net. To capture larval salamanders, position the net front of the salamander's head, and gently touch the tail; more often than not they will move forward into the net. Replace cover objects that are lifted to their original position to minimize habitat disturbance. Another technique used to capture salamander larvae is to attach a 200 ml suction bulb to a small rubber tube of sufficient diameter to allow salamander larvae to enter. Place the tube near the larvae and use the suction bulb to capture the larvae in the tube. This method is useful in areas of the stream where larvae are hiding in such a way that nets are strainers will not work. A high intensity head light may be helpful in some headwater streams due to low light conditions under tree canopy. Spring Salamanders (*Gyrinophilus*) are often found at the terminal limits of a PHWH stream, near the ground water source. These salamanders are known to bury into gravel substrate as adults, although larvae can be located under rocks throughout the stream channel. When searching for salamanders near a ground water source, extra time should be spent digging into any gravel substrate that may be present.

All captured salamanders should be placed into a plastic container or zip-loc bag (double) so that species can be identified and the total number of each type counted. Take note of any salamanders that escape capture and include those in the total tally for the 30 ft (9.1 m) sample zone. At least 3 ft (about 1 m) on each side of the wet portion of the stream channel should also be searched for juvenile and adult salamanders. These age classes often migrate away from the water in search of food or places to hide from predators.

Place all captured salamanders into a white tray with a small amount of water. Gills on the head of the larvae will be visible against the white background to allow them to be identified. Record the total number of each salamander species collected on page 3 of the PHWH Form. Include in the tally the total number of salamanders observed but that escaped capture. After voucher specimens are taken, replace all remaining salamanders into stream section from which they were collected.

The goal of the PHWH stream sampling effort for salamanders is to document the presence-absence of different species of salamanders, thus all available micro habitats should be searched. At least 30 minutes should be spent searching for salamanders, and the entire 30 ft (9.1 m) zone should be surveyed during the survey. Emphasis should be placed on the collection of salamander larvae since this age class is the best predictor that the salamander population is resident in the stream on an annual basis. However, a mixture of juvenile and mature salamanders at a site also indicates that a population is using the stream channel for reproduction.

Within each 30 ft (9.1 m) sample zone, salamander abundance can be estimated using the Visual Encounter Survey (VES) technique as described by Heyer et al. (1994). Time is expressed as the number of person-hours of searching within the 30 ft (9.1 m) zone. Record exact time to the minute on the PHWH Form. A Visual Encounter Survey can be used to determine the salamander species richness of a stream segment, and to estimate the relative abundances of species on a time basis. Because turbidity can greatly effect the results of a VES, monitoring should only be conducted when water is clear. Extra care must taken if the sampling occurs during leaf fall in September thru November of the year.

2.5.11 (b) (2) Salamander Voucher Specimens

Collect voucher specimens and transport live to the laboratory for proper preservation. Place captured salamanders into double plastic bags (or plastic containers with air holes) with some moist leaf litter or moss. Place in a cooler with block ice for transport to the lab for preparation of scientific voucher specimens. At least five larvae and two juvenile-adults should be preserved for each species "type" observed in the field, if possible.

At the lab, salamanders should be killed as quickly and humanely as possible in a way that leaves them in a relaxed position. Salamanders may be killed by drowning in a weak ETOH (15%-20%) solution. It may be necessary to straighten the organism several times prior to death in order to ensure that they are not fixed in a curled position. Once dead, the specimen is fixed by placing in a tray lined with white paper towel soaked with 10% formalin. The individual should be laid out straight with the limbs pointing forward parallel to the body. The toes should be spread with the palmar surface facing down. Cover with a second paper towel and add 10% formalin to the tray to a depth of 1 cm. Cover the tray to stop formalin odors. The salamanders should harden somewhat within 2 hours. Specimens should then be transferred to a jar of 10% formalin for shipment or short term storage. Place a field tag in/on the jar which includes date, collector name, county, township, and stream identification as listed on the field evaluation form. For long term storage, run the formalin preserved salamanders through a series of first distilled water, then 15% ETOH, 30% ETOH, and finally 70% ETOH. Salamanders should stay in each solution for 24 hours.

2.5.11 (c) Headwater Benthic Macroinvertebrates

Benthic macroinvertebrates are to be collected by searching representatives of all available habitat types within the 200 ft (61 m) stream reach segment. Search riffles, runs, pools, and along stream margins. Visually scan the stream bottom for organisms and their retreats. Examine numerous larger substrates such as rocks, woody debris, and leaf packs. Place a small net (about 10 inches wide with a curved or flexible rim) with small mesh size downstream from substrates when they are disturbed to capture dislodged specimens. Wash small amounts of fine particle sized substrates through the net and examine the contents with a white enamel pan. Use a white pan to sort through the rocks and debris and to help identify and keep track of the taxa you are finding. It may be helpful to use a pipette to remove small, quick organisms from the pan. Collect invertebrates for a least 30 minutes from all available habitats and thereafter until no new taxa are found.

Record on page 4 of the PHWH Form the presence and relative abundance (i.e., rare, common, abundant) of all taxa collected as you find them within the sampling area. For the mayfly, caddisfly, stonefly groups (i.e., the EPT taxa) record on the field sheet the family or genus name of the different taxa observed for each group. The investigator should have a working knowledge of macroinvertebrate taxonomy to at least the family level. Special care must be given to search for the very small and often cryptic chironomid (midge) larvae. Many cool-cold taxa that are associated with Class III-PHWH streams are found in this taxonomic group. Special care must also be taken during times of leaf fall.

Voucher specimens of all taxa should be collected and preserved in 70 % ETOH or higher. Place a field tag in the jar which includes date, collector name, county, township, and stream identification as listed on the PHWH Form.

2.5.11 (c) (1) Headwater Macroinvertebrate Field Evaluation Index (HMFEI)

The overall condition of the benthic macroinvertebrate community can be evaluated using a modified version of the Ohio DNR Stream Quality Monitoring scoring system developed for PHWH streams, referred to as the Headwater Macroinvertebrate Field Evaluation Index (HMFEI). The HMFEI is designed on the concept that the cool Class III streams will have a higher diversity of taxa, in particular the groups of taxa (Group 3 Taxa in Table 6) that are usually associated with high quality stream faunas. The HMFEI is a rapid bio-assessment field sampling method developed by the Ohio EPA. It has been shown to be a good predictor of the various classes of PHWH streams in Ohio. The HMFEI is designed for use in the field, but does require field level identification that range from Phylum to Family for most groups and Family or Genus level of separation for the EPT taxa, in order to classify different assemblages of benthic macroinvertebrates found in headwater streams. Although the HMFEI can be a useful rapid assessment tool, it is inferior to a more detailed identification of cool-cold water adapted species of benthic macro-invertebrates as obtained through analysis of a voucher sample to the lowest practical taxonomic level back at the laboratory. A list of benthic macroinvertebrate species that are associated with cool-cold PHWH streams is provided in Attachment 3.

2.5.11.(c) (2) Using the Headwater Macroinvertebrate Field Evaluation Index (HMFEI) to Assign an Aquatic Life Use Designation to a PHWH Stream.

Table 6 lists the groups of benthic macroinvertebrate taxa to be scored using the HMFEI evaluation. The final HMFEI is calculated by multiplying each taxa present by the appropriate scoring value, with the exception of the mayfly, caddisfly, and stonefly groups for which each field recognizable taxa belonging to these groups are multiplied by the scoring value. Use page 4 of the PHWH Form to record the information needed to calculate a final HMFEI score.

The HMFEI is reasonably good at separated Class III (cool-cold water adapted) from Class II (warmwater adapted) benthic macroinvertebrate assemblages. A HMFEI score of 20 provides separation between these two types of streams at about the 90^{th} %ile level. Because the HMFEI is designed to be used with a level of taxonomy that is inferior to the identification of a thorough voucher sample to the lowest practical level at the laboratory, it is crucial that a thorough field collection be made and that the biologist conducting the survey have at least a Family level of taxonomic expertise. A HMFEI score less than 7 can be used to identify a potential Class I-PHWH stream, which has poor biological potential. HMFEI scores between 7 and 19 suggest a Class II type benthic macroinvertebrate community is present, unless obvious sources of pollution (toxic chemicals, heated water, sewage, nutrient enrichment, etc.) have lowered a true Class III cool water stream into the 7 to 19 HMFEI range.

Table 6. Headwater Macroinvertebrate Field Evaluation Index (HMFEI) scoring categories for use in assessing primary headwater streams in Ohio.

Group 1 Taxa (scoring value = 1)	**Group 2 Taxa (scoring value = 2)**	**Group 3 Taxa (scoring value = 3)**
Sessile Animals (Porifera, Cnidaria, Bryozoa)	Crayfish (Decapoda)	Mayfly Nymphs (Ephemeroptera)
Aquatic Worms (Turbellaria, Oligochaeta, Hirudinea)	Dragonfly Nymphs (Anisoptera)	Stonefly Nymphs (Plecoptera)
Sow Bugs (Isopoda)	Riffle Beetles (Dryopidae, Elmidae, (Ptilodactylidae)	Fishfly Larvae (Corydalidae)
Scuds (Amphipoda)		Caddisfly Larvae (Trichoptera)
Water Mites (Hydracarina)		Water Penny Beetles (Psephenidae)
Damselfly Nymphs (Zygoptera)		Cranefly Larvae (Tipulidae)
Alderfly Larvae (Sialidae)		
Other Beetles (Coleoptera)		
Midges (Chironomidae)		
Larvae of Other Flies (Diptera)		
Snails (Gastopoda)		
Clams (Bivalvia)		

Note: Hemiptera (True Bugs) do not receive any points

An example of a HMFEI scoring procedure is given below. In this example, eight (8) major Taxa Groups were collected (see Table 6 for a list of major taxa groups). A voucher sample was collected for each of the major taxa observed as follows:

Taxa Group	Group Type	Metric Scores
Turbellaria (aquatic worm)	1	1
Mayflies: 2 taxa	3	2 x 3 = 6
Corydalidae (fishfly)	3	3
Caddisflies: 3 taxa	3	3 x 3 = 9
Tipulidae	3	3
Blackflies (other diptera)	1	1
Midges	1	1
Snails	1	1
	Total HMFEI Score	25

Based on a final HMFEI score of 25, this stream reach has a benthic macroinvertebrate assemblage associated with Class III-PHWH streams. The HMFEI can be conducted any time of the year. However, for the most representative results it is suggested that it be conducted during the summer (June to September) in order to avoid the taxa increase during the spring time (January to May) and the sampling difficulty associated with leaf fall in the fall (October to December).

The following guidelines are to be used with the HMFEI evaluation to make a decision on the appropriate aquatic life use designation to give to the undesignated PHWH stream:

IF Final HMFEI Score is >19 ,	Then CLASS III	PHWH STREAM
IF Final HMFEI Score is 7 to 19 ,	Then CLASS II	PHWH STREAM
IF Final HMFEI Score is < 7,	Then CLASS I	PHWH STREAM

A more detailed identification of the macroinvertebrate voucher sample could also be conducted to determine if three or more cool-cold water macroinvertebrate taxa are present as listed in Attachment 3. This analysis can be conducted any time of the year, but is best conducted from January to September in order to avoid the sampling difficulty associated with leaf fall (October to December).

2.5.11 (d) Using a Biological Assessment to Assign an Aquatic Life Use Designation

The following criteria must be followed to assign an appropriate existing or aquatic life use designation to an unnamed PHWH stream based on assessment of biological communities:

Determination of a Class III-PHWH stream (cool-cold water adapted community)

A definitive determination of a Class III-PHWH stream is made by the presence of cold water adapted species of fish (brook trout, redside dace, mottled sculpin, brook stickleback) **and/or** by the presence of <u>reproducing populations</u> of one of the eight species (subspecies) of obligate aquatic salamander species from the genera *Eurycea*, *Pseudotriton*, or *Gyrinophilus* as listed in Tables 4 and 5 (pages 31 to 34). A Class III-PHWH stream can also be identified by a detailed taxonomic evaluation of the benthic macroinvertebrate community using the cool water species list found in Attachment 3. The presence of <u>three or more species</u> of cool water benthic invertebrates from this list can be used to assign a Class III-PHWH use designation to an undesignated headwater stream.

As an alternative to a detailed laboratory identification of cool water macroinvertebrate taxa, the qualitative Headwater Macroinvertebrate Field Evaluation Index (HMFEI) method can also be used to assign an existing use to a PHWH stream as detailed on page 4 of the PHWH Form (Attachment 1) of this manual. However, where data exists on both a detailed taxonomic evaluation using the list of cool water taxa in Attachment 3, and the field HMFEI assessment, the more detailed taxonomic approach to genus-species level of taxonomy will be used to make a final PHWH stream use designation.

Determination of a Class II-PHWH stream (warm water adapted community)

A Class II-PHWH stream will be identified by the presence of warmwater adapted species of vertebrates (either fish or amphibians) **and/or** warmwater species of benthic macroinvertebrates that score a HMFEI score of 7 to19. Lists of warmwater vertebrates found in Class II-PHWH streams are found in Tables 3 thru 5.

Determination of a Class I-PHWH stream (ephemeral flow)

A PHWH stream that lacks any evidence of obligate vertebrate aquatic life, or has a benthic macroinvertebrate HMFEI score less than 7 pts., has a very high probability of becoming ephemeral. These types of headwater streams represent the highest percentage of all PHWH streams in Ohio (see Table 1, page 6). Woodland salamanders of the genus *Plethodon* may use Class I-PHWH corridors for migration and feeding.

2.6. Summary of Steps to Use to Assign an Aquatic Life Use Designation to a PHWH Stream.

The follow steps outline a sequential protocol to be used to reach a final aquatic life use decision for an undesignated PHWH stream. The sequence presented is in rank order of techniques that are least costly and time consuming to those that are most costly and time consuming. The HHEI allows for determination of aquatic life use *potential*. However, a biological survey must be conducted to determine if that potential is being realized, or to determine if the existing use is being impaired by a wastewater discharge. A weight-of-evidence approach should be used to make a final use designation determination. Increased confidence that a correct decision has been made will be obtained when more than one of the steps below reaches the same PHWH stream classification.

1. Conduct an HHEI Assessment. Use the decision making flowchart in Figure 7, page 23, to determine *potential* aquatic life use designation.

If there is reason to question the HHEI survey results, then

2. Conduct a rapid bio-assessment of the benthic macroinvertebrate community and vertebrate community. Apply the macroinvertebrate HMFEI scoring criteria from page 4 of the PHWH Form (Attachment 1). Apply the salamander criteria found in Table 5, pages 32-34. The presence of cold water fish indicator species indicates the stream is a Class III-PHWH.

If there is reason to question the HMFEI results, and no cold-cool water vertebrates are present, then

3. Identify macroinvertebrate voucher sample to the lowest taxonomic level (seek Ohio EPA guidance) in order to identify the presence of cool water adapted taxa as listed in Attachment 3. If 3 or more cool water taxa are collected, the stream is a Class III-PHWH stream.. If < 3 cool water taxa, assign a Class II existing use designation.

2.7 Proposed Levels of Protection for PHWH Stream Classes

Different types and degrees of aquatic life protection should be given to protect and restore the biological integrity present in the three different classes of PHWH streams in Ohio. The following discussion presents ideas that should be considered if primary headwater streams are to be modified.

Class I-PHWH streams, due to their ephemeral nature, should require non-aquatic life type of protection of watershed hydrologic function, such as mitigation of water energy, sediment retention in flood plain areas, protection of downstream uses.

Class II-PHWH streams represent a moderately diverse assemblage of vertebrates and benthic macroinvertebrates that are well adapted to a spectrum of warmwater flow hydrology, similar to the current WWH aquatic life use designation found in OAC , Chapter 3745-1. As such, Class II-PHWH streams should receive aquatic life use protection identical to larger streams currently designated WWH in OAC, Chapter 3745-1.

Class III-PHWH streams represent a very unique assemblage of cool-cold water adapted species of fish, and/or salamanders, and/or cool water adapted benthic macroinvertebrates that require flowing water on an annual basis for the resident species to complete their life cycles. On a statewide basis, Class III-PHWH streams are relatively rare, representing somewhere about 16 % of all PHWH streams less than 1.0 mi^2 (259 ha) in the state (Table 1, page 6). These streams may be more abundant in localized geologic areas of the state associated with groundwater recharge glacial end moraines or similar geologic formations. Class III-PHWH streams should receive water quality criteria protection identical to larger streams currently designated Cold Water Habitat (CWH), OAC , Chapter 3745-1. All efforts should be taken to leave natural riparian and flow hydrology in place for Class III-PHWH streams, given their unique requirement for perennial flowing cool-cold water. If a Class III PHWH stream must be modified, then attempts should be made to bio-engineer the stream channel and flow hydrology back to natural conditions.

2.8 Overview of the PHWH Assessment Process

The following sequence of tasks presents a generalized summary of the various steps involved in a PHWH stream assessment.

Desktop Evaluation

Step 1 Obtain NRCS county soil map, and USGS 7.5 min. topographic map, for the watershed area under investigation.

Step 2 Delineate property boundary on the NRCS soil map. Determine total linear feet (m) of all potential PHWH streams.

Step 3 Using either the USGS topographic map, or the NRCS soil map, determine total watershed area for PHWH streams at the most downstream location of the property boundary.

Step 4 Prepare to conduct an on-site PHWH stream evaluation if watershed area < 1 mi^2 (259 ha). Prepare to conduct a QHEI/WWH stream evaluation if watershed area > 1 mi^2 , or deep pools > 40 cm maximum depth.

Where determined to be appropriate by a qualified biologist, a PHWH evaluation can be conducted in streams with watershed areas > 1 mi^2 (259 ha), or a QHEI/WWH evaluation can be conducted in streams with watershed areas < 1 mi^2 .

Field Reconnaissance and Sampling

Step 5 Determine if baseflow and Q 7-10 conditions are present. If **no**, do not proceed with evaluation, if **yes**, proceed. If less than Q 7-10 flow is present in the area, water quality standard use designations cannot be assigned.

Step 6 Delineate (with flags) 200 ft (60m) stream reach sections for each mainstem PHWH stream. Begin stream reach delineation starting at the most downstream property boundary, and continue in an upstream direction. Tributaries of the mainstem less than 200 ft should be evaluated as separate PHWH streams. Very small seepage areas can be assessed as being part of the 200 ft stream reach zone.

Step 7 Record observational data on the PHWH Form (Attachment 1) about the physical nature of the stream corridor including type of flow, condition of riparian zone, channel modification, etc. Take photographs.

Step 8 If appropriate, conduct water chemistry sampling before walking in the stream water and adding turbidity.

Step 9 If conducting a biological survey, *start with amphibians* (salamanders), then fish, and finally benthic macro-invertebrates. Collect voucher specimens. The sequence of sampling from vertebrates to invertebrates is important because water with low turbidity is very important to accurately conduct a visual search for aquatic salamander larvae. However, it is also important that clear water be present when conducting the fish and invertebrate surveys. Thus you must wait until the water is clear to conduct these surveys . Record all biological data on pages 3 and 4 of the PHWH Form.

Step 10 If conducting a rapid HHEI habitat assessment, measure <u>bankfull width</u>, <u>maximum pool depth</u>, and <u>substrate composition</u>. Record data on pages 1 and 2 of the PHWH Form. Be sure to complete the entire PHWH Form in Attachment 1.

Step 11 Optional habitat measures for parameters such as gradient, flood prone width, and quantitative pebble counts may now be conducted if deemed necessary.

<u>Final Report</u>

Step 12 Use data from the HHEI evaluation(Attachment 1) **and/or** the results of a biological survey to determine appropriate Class I, II, III, aquatic life existing use. Use the decision making flowchart in Figure 7, page 23 when using the HHEI information. Use the guidelines from Section 2.5.11(d), page 40 when using biological data. See also the summary of steps in Section 2.6 on page 41 on how to reach a final decision on appropriate aquatic life use designation.

Results from the biological survey will take precedence over results from a HHEI survey unless there is reason to believe that chemical stressors are present, which could limit the presence of biological communities (i.e., warm water from lack of riparian cover, toxic levels of heavy metals, elevated ammonia-N, low dissolved oxygen, low pH, excessive stream bed siltation, etc). Where chemical stressor are shown to be present, the results from the HHEI survey can be used to identity the *potential* PHWH stream use designation.

Summarize results of the field evaluation and write a report with recommended PHWH stream use designation(s) for the stream investigated.

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Attachment 1

The Ohio EPA Primary Headwater Habitat Evaluation Form (PHWH Form)

Primary Headwater Habitat Evaluation Form

HHEI Score (sum of metrics 1, 2, 3) :

SITE NAME/LOCATION ____

______________SITE NUMBER__________ RIVER BASIN _______________ DRAINAGE AREA (mi^2) ________

LENGTH OF STREAM REACH (ft) ________ LAT. _________ LONG. ________ RIVER CODE _______ RIVER MILE _______

DATE __________ SCORER ____________ COMMENTS _______________________________

NOTE: Complete All Items On This Form - Refer to "Field Evaluation Manual for Ohio's PHWH Streams" for Instructions

STREAM CHANNEL MODIFICATIONS: ❐ NONE / NATURAL CHANNEL ❐ RECOVERED ❐ RECOVERING ❐ RECENT OR NO RECOVERY

HHEI Metric Points

1. SUBSTRATE (Estimate percent of every type of substrate present. Check *ONLY* two predominant substrate *TYPE* boxes (Max of 32). Add total number of significant substrate types found (Max of 8). Final metric score is sum of boxes A & B.

TYPE		PERCENT	TYPE		PERCENT
❐ ❐	BLDR SLABS **[16 pts]**	______	❐ ❐	SILT **[3 pt]**	______
❐ ❐	BOULDER (>256 mm) **[16 pts]**	______	❐ ❐	LEAF PACK/WOODY DEBRIS **[3 pts]**	______
❐ ❐	BEDROCK **[16 pt]**	______	❐ ❐	FINE DETRITUS **[3 pts]**	______
❐ ❐	COBBLE (65-256 mm) **[12 pts]**	______	❐ ❐	CLAY or HARDPAN **[0 pt]**	______
❐ ❐	GRAVEL (2-64 mm) **[9 pts]**	______	❐ ❐	MUCK **[0 pts]**	______
❐ ❐	SAND (<2 mm) **[6 pts]**	______	❐ ❐	ARTIFICIAL **[3 pts]**	______

Total of Percentages of Bldr Slabs, Boulder, Cobble, Bedrock ________

SCORE OF TWO MOST PREDOMINATE SUBSTRATE TYPES: (A) ☐ **TOTAL NUMBER OF SUBSTRATE TYPES:** (B) ☐

Substrate Max = 40

A + B

2. Maximum Pool Depth ***(Measure the maximum pool depth within the 61 meter (200 ft)*** evaluation reach at the time of evaluation. Avoid plunge pools from road culverts or storm water pipes) (Check *ONLY* one box):

❐	> 30 centimeters **[20 pts]**	❐	> 5 cm - 10 cm **[15 pts]**
❐	> 22.5 - 30 cm **[30 pts]**	❐	< 5 cm **[5 pts]**
❐	> 10 - 22.5 cm **[25 pts]**	❐	NO WATER OR MOIST CHANNEL **[0 pts]**

COMMENTS________________________________ **MAXIMUM POOL DEPTH (centimeters):**

Pool Depth Max = 30

3. BANK FULL WIDTH (Measured as the average of 3-4 measurements) **(Check *ONLY* one box):**

❐	> 4.0 meters (> 13') **[30 pts]**	❐	> 1.0 m - 1.5 m (> 3' 3" - 4' 8") **[15 pts]**
❐	> 3.0 m - 4.0 m (> 9' 7" - 13') **[25 pts]**	❐	≤ 1.0 m (≤ 3' 3") **[5 pts]**
❐	> 1.5 m - 3.0 m (> 9' 7" - 4' 8") **[20 pts]**		

COMMENTS________________________________ **AVERAGE BANKFULL WIDTH (meters)**

Bankfull Width Max=30

This information must also be completed

RIPARIAN ZONE AND FLOODPLAIN QUALITY ☆NOTE: River Left (L) and Right (R) as looking downstream☆

RIPARIAN WIDTH		FLOODPLAIN QUALITY			
L R	(Per Bank)	L R	(Most Predominant per Bank)	L R	
❐ ❐	Wide >10m	❐ ❐	Mature Forest, Wetland	❐ ❐	Conservation Tillage
❐ ❐	Moderate 5-10m	❐ ❐	Immature Forest, Shrub or Old Field	❐ ❐	Urban or Industrial
❐ ❐	Narrow <5m	❐ ❐	Residential, Park, New Field	❐ ❐	Open Pasture, Row Crop
❐ ❐	None	❐ ❐	Fenced Pasture	❐ ❐	Mining or Construction

COMMENTS____

FLOW REGIME *(At Time of Evaluation)* (Check *ONLY* one box):

❐ Stream Flowing ❐ Moist Channel, isolated pools, no flow (Intermittent)

❐ Subsurface flow with isolated pools (Interstitial) ❐ Dry channel, no water (Ephemeral)

COMMENTS____

SINUOSITY (Number of bends per 61 m (200 ft) of channel) (Check *ONLY* one box):

❐ None	❐ 1.0	❐ 2.0	❐ 3.0
❐ 0.5	❐ 1.5	❐ 2.5	❐ >3

STREAM GRADIENT ESTIMATE

❐ Flat (0.5 ft/100 ft) ❐ Flat to Moderate ❐ Moderate (2 ft/100 ft) ❐ Moderate to Severe ❐ Severe (10 ft/100 ft)

ADDITIONAL STREAM INFORMATION (This Information Must Also be Completed):

QHEI PERFORMED? - ❒ Yes ❒ No QHEI Score __________ (If Yes, Attach Completed QHEI Form)

DOWNSTREAM DESIGNATED USE(S)

❒ WWH Name: ________________________________ Distance from Evaluated Stream _____________

❒ CWH Name: ________________________________ Distance from Evaluated Stream _____________

❒ EWH Name: ________________________________ Distance from Evaluated Stream _____________

MAPPING: ATTACH COPIES OF MAPS, INCLUDING THE ENTIRE WATERSHED AREA. CLEARLY MARK THE SITE LOCATION

USGS Quadrangle Name:___________________ NRCS Soil Map Page:_______ NRCS Soil Map Stream Order ______

County: ______________________ Township / City:______________________

MISCELLANEOUS

Base Flow Conditions? (Y/N):_______ Date of last precipitation:____________________ Quantity:_____________

Photograph Information: ____

Elevated Turbidity? (Y/N): _________ Canopy (% open): ____________

Were samples collected for water chemistry? (Y/N): _______ (Note lab sample no. or id. and attach results) Lab Number:_________________

Field Measures: Temp (°C)_______ Dissolved Oxygen (mg/l) _________ pH (S.U.) ________ Conductivity (µmhos/cm) _______________

Is the sampling reach representative of the stream (Y/N)_____ If not, please explain:______________________

____

Additional comments/description of pollution impacts:______________________

____

BIOTIC EVALUATION

Performed? (Y/N): ________ (If Yes, Record all observations. Voucher collections optional. NOTE: all voucher samples must be labeled with the site ID number. Include appropriate field data sheets from the Primary Headwater Habitat Assessment Manual)

Fish Observed? (Y/N)_____ Voucher? (Y/N)_____ Salamanders Observed? (Y/N)_____ Voucher? (Y/N)_____
Frogs or Tadpoles Observed? (Y/N)____ Voucher? (Y/N)____ Aquatic Macroinvertebrates Observed? (Y/N)____ Voucher? (Y/N)____

Comments Regarding Biology:______________________

____

____

DRAWING AND NARRATIVE DESCRIPTION OF STREAM REACH (This must be completed):

Include important landmarks and other features of interest for site evaluation and a narrative description of the stream's location

FLOW ➜

PHWH STREAM BIOLOGICAL CHARACTERISTICS FIELD SHEET:

1. Fish:

Voucher Specimens Retained? (circle) Y / N Time Spent (minutes):______
Sample Method _____________ Stream Length Assessed (meters) ____________

Species	Number Caught	Notes

2. Salamanders:

Voucher Specimens Retained? (circle) Y / N Time Spent (minutes):_______
Sample Method ________________ Stream Length Assessed (meters) _________

Species *(Genus)*	# Larvae	# Juveniles/Adults	Total Number
Mountain Dusky (*Desmognathus ochrophaeus)*			
Northern Dusky (*Desmognathus fuscus)*			
Two-lined *(Eurycea bislineata)*			
Long-tailed *(Eurycea longicauda)*			
Cave (*Eurycea lucifuga)*			
Red *(Pseudotriton ruber)*			
Mud *(Pseudotriton montanus)*			
Spring *(Gyrinophilus porphyriticus)*			
Mole spp. *(Ambystoma spp.)*			
Four-toed *(Hemidactylium scutatum)*			
Other (name)			
Total			

Notes on Vertebrates: ____

3. Macroinvertebrate Scoring Sheet:

THE HEADWATER MACROINVERTEBRATE FIELD EVALUATION INDEX (HMFEI) SCORING SHEET

Indicate Abundance of Each Taxa Above each White Box.

Record HMFEI Scoring Value Points Within each Box.

For EPT taxa, also indicate the different taxa present.

Key: V = Very Abundant (> 50); **A** = Abundant (10 -50); **C** = Common (3 -9); **R** = Rare (< 3)

Sessile Animals **(Porifera, Cnidaria, Bryozoa)** (HMFEI pts = 1)	Crayfish (**Decapoda**) (HMFEI pts = 2)	Fishfly Larvae (**Corydalidae**) (HMFEI pts = 3)
Aquatic Worms (**Turbellaria, Oligochaeta, Hirudinea**) (HMFEI pts = 1)	Dragonfly Nymphs (**Anisoptera**) (HMFEI pts = 2)	Water Penny Beetles (**Psephenidae**) (HMFEI pts = 3)
Sow Bugs (**Isopoda**) (HMFEI pts = 1)	Riffle Beetles (**Dryopidae, Elimidae, Ptilodactylidae**) (HMFEI pts = 2)	Cranefly Larvae (**Tipulidae**) (HMFEI pts = 3)
Scuds (**Amphipoda**) (HMFEI pts = 1)	Larvae of other Flies (**Diptera**) Name: (HMFEI pts = 1)	**EPT TAXA*** Total No. EPT Taxa = ______
Water Mites (**Hydracarina**) (HMFEI pts = 1)	Midges (**Chironomidae**) (HMFEI pts = 1)	Mayfly Nymphs (**Ephemeroptera**) Taxa Present: [HMFEI pts = No. Taxa (x) 3]
Damselfly Nymphs (**Zygoptera**) (HMFEI pts = 1)	Snails (G**astropoda**) (HMFEI pts = 1)	
Alderfly Larvae (**Sialidae**) (HMFEI pts = 1)	Clams (**Bivalvia**) (HMFEI pts = 1)	Stonefly Nymphs (**Plecoptera**) Taxa Present: [HMFEI pts = No. Taxa (x) 3]
Other Beetles (**Coleoptera**) (HMFEI pts = 1)	Other Taxa :	
Other Taxa:	Other Taxa:	Caddisfly Larvae (**Trichoptera**) Taxa Present: [HMFEI pts = No. Taxa (x) 3]
Other Taxa:	Other Taxa	

*Note: EPT identification based upon Family or Genus level of taxonomy

Voucher Sample ID__________________________ Time Spent (minutes):__________________________

Notes on Macroinvertebrates: (Predominant Organisms; Other Common Organisms; Diversity Estimate)

____

____

____

Final HMFEI Calculated Score (Sum of All White Box Scores) = ☐

IF Final HMFEI Score is > 19, Then CLASS III PHWH STREAM
IF Final HMFEI Score is 7 to 19, Then CLASS II PHWH STREAM
IF Final HMFEI Score is < 7, Then CLASS I PHWH STREAM

Attachment 2

Field Checklist for Primary Headwater Stream Sampling

Physical-Chemical Sampling:

- ☐ Attachment 1 field data form in manual with clip board, pencil
- ☐ 100 foot tape measure, cloth
- ☐ ruler (in cm)
- ☐ 2 color flag markers (to mark ends of sample zone)
- ☐ 30 ft of string to measure bankfull width, with two metal stakes
- ☐ bubble type line level
- ☐ stop watch
- ☐ camera
- ☐ film for camera
- ☐ clip board, pencils
- ☐ carry bag
- ☐ chemical meters (dissolved oxygen, temperature, pH, conductivity)
- ☐ Two qt. cubi containers for potential water samples for nutrients and metals
- ☐ Mosquito repellant
- ☐ Optional: GPS unit for lat./long.

Biological Sampling:

- ☐ hip waders or chest waders (knee boots not recommended)
- ☐ fine mesh kick net for invertebrate sampling
- ☐ white sorting pans (2)
- ☐ fine tip forceps
- ☐ specimen jars: 70% alcohol for invertebrates, and formalin solution for fish voucher samples
- ☐ large tea strainer or fine mesh small handle invertebrate net for salamanders
- ☐ hard plastic container with air holes in lid for salamander collection
- ☐ heavy duty plastic bags (4) for transport of salamanders to lab
- ☐ small cooler with ice or block ice for salamander transport and water samples
- ☐ marker flags (2) to mark ends of sample zone
- ☐ Optional: 30 foot line to measure length of salamander sample zones
- ☐ Optional: 10 foot fish seine
- ☐ Optional: High intensity head lamp

Attachment 3 : List of Cool Water Benthic Macroinvertebrates found in Class III-PHWH Streams

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Attachment 3, Table 1. Revision to the Ohio EPA macroinvertebrate cool water taxa list. Taxa added since the last revision are followed by an (*). Taxa whose species name has changed due to recent taxonomic revisions are followed by an (~). Taxa that have been removed from the list are listed at the bottom of this page.

Crustacea

Gammarus minus

Ephemeroptera

Ameletus sp.

Baetis tricaudatus*

Epeorus sp.

Habrophlebiodes sp.*

Dannella simplex*

Litobrancha recurvata

Odonata

Lanthus parvulus

Plecoptera

Peltoperla sp.

Amphinemura sp.

Soyedina sp.

Leuctra sp.

Eccoptura xanthenes*

Megaloptera

Nigronia fasciatus

Trichoptera

Dolophilodes sp.

Wormaldia sp.

Ceratopsyche slossonae

Ceratopsyche ventura*

Diplectrona sp.

Parapsyche sp.

Rhyacophila sp. (excluding R. lobifera)

Glossosoma sp.

Oligostomis sp.*

Frenesia sp.

Goera sp.

Lepidostoma sp.

Psilotreta rufa*

Molanna sp.

Diptera

Radotanypus florens

Trissopelopia ogemawi

Zavrelimyia sp.

Diamesa sp.

Pagastia orthogonia* (= P. species A)

Odontomesa ferringtoni*

Prodiamesa olivacea

Brillia parva

Chaetocladius piger ~

Corynoneura n. sp. 5

Eukiefferiella devonica group

Heleniella sp.

Heterotrissocladius marcidus

Metriocnemus eurynotus ~

Parachaetocladius sp.

Parametriocnemus sp.

Psilometriocnemus triannulatus*

Rheocricotopus eminellobus*

Thienemanniella boltoni ~

Polypedilum (P.) albicorne

Polypedilum (P.) aviceps

"Constempellina" n. sp. 1

Micropsectra sp.

Paratanytarsus n. sp. 1

"Stempellina" n. sp. 1

Zavrelia n. sp. 1*

Dicranota sp. *

Pedicia sp. *

Thaumalea americana *

Apsectrotanypus johnsoni *

Macropelopia decedens

Meropelopia sp.

Taxa Removed from Previous Lists of Cool Water Macroinvertebrates:

Diplocladius cultriger - emerges primarily in the spring time and has been collected primarily from warmwater streams.

Orthocladius (O.) sp. - emerges primarily in the spring time and has been collected primarily from warmwater streams.

by: Mike Bolton, Ohio EPA, Division of Surface Water, March 2001,

Attachment 3, Table 2. Table of cool water macroinvertebrate taxa with statistical measures of the number and percentage of cool water taxa (using the revised 1999 list) at the collection sites during the summer sampling period (June 15 to September 30) and references supporting the cool water habitat preference of these taxa.

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Taxa (n)	**25th %ile No. taxa**	**50th %ile No. taxa**	**75th %ile No. taxa**	***75th %ile % taxa***	**References**
Gammarus minus (25)	*1*	*3*	*3*	-	*Holsinger (1972: p. 25)*
Ameletus sp. (spring em.)	-	-	-	-	*Burks (1953: p. 103)*
Baetis tricaudatus (62)	*1*	*3*	*6*	*25.4*	
Epeorus sp. (spring em.)	-	-	-	-	*Burks (1953: p. 195)*
Habrophlebiodes sp. (6)	*3*	*5*	*6*	-	
Dannella simplex (8)	*3*	*4.5*	*6*	*11.0*	
Litobrancha recurvata (2)	-	*15*	-	-	*McCafferty (1975: p. 478)*
Lanthus parvulus (9)	*1*	*2*	*3*	*0.9*	*Carle (1980: p. 178)*
Peltoperla sp. (1)	-	*3*	-	-	*Surdick & Kim (1976: p.16)*
Amphinemura sp. (7)	*3*	*7*	*9*	-	
Soyedina sp. (3)	-	*6*	-	-	*Harper & Hynes (1971: p. 1140)*
Leuctra sp. (37)	*2*	*4*	*8*	*25.3*	
Eccoptura xanthenes (4)	-	*6*	-	-	*Stewart & Stark (1988: p. 308)*
Nigronia fasciatus (38)	*2*	*3*	*4*	*2.5*	*Neunzig (1966: p. 15)*
Dolophilodes distinctus (24)	*4*	*6.5*	*7*	*25.4*	*Wiggins (1996: p. 154)*
Wormaldia sp. (5)	*6*	*8*	*8*	-	*Ross (1944: p. 47)*
Ceratopsyche slossonae (326)	*1*	*2*	*4*	*7.5*	*Schuster & Etnier (1978: p. 49)*
Ceratopsyche ventura (1)	-	*10*	-	-	*Schefter & Wiggins (1986: p. 81)*
Diplectrona sp. (83)	*2*	*3*	*5*	*7.9*	*Wiggins (1996: p. 134)*
Parapsyche sp. (spring em.?)	-	-	-	-	*Wiggins (1996: p. 144)*
Rhyacophila sp. (7) (excluding R. lobifera)	*4*	*5*	*9*	-	*Flint (1962: pp. 482, 492)*
Glossosoma sp. (50)	*3*	*4*	*6*	*25.3*	*Wiggins (1996: p. 60)*
Oligostomis sp. (1)	-	*6*	-	-	*Wiggins (1996: p. 388)*
Frenesia sp. (3)	-	*6*	-	-	*Wiggins (1996: p. 308)*

Attachment 3, Table 2 continued. List of cool water macroinvertebrate taxa.

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Taxa (n)	25th %ile No. taxa	50th %ile No. taxa	75th %ile No. taxa	75th %ile % taxa	References
Goera sp. (4)	-	*12.5*	-	-	*Ross (1944: p. 257)*
Lepidostoma sp. (8)	*6*	*8.5*	*10*	-	*Wiggins (1996: p. 244)*
Psilotreta rufa (1)	-	*11*	-	-	*Parker & Wiggins (1987: p. 21)*
Molanna sp. (5)	*6*	*8*	*14*	-	*Wiggins (1996: p. 354)*
Dicranota sp. (35)	*2*	*3*	*6*	*5.0*	
Pedicia sp. (spring em.?)	-	-	-	-	*Alexander (1942: p.344)*
Thaumalea americana (1)	-	*4*	-	-	*Stone (1964: p. 120)*
Apsectrotanypus johnsoni	-	-	-	-	*Fittkau & Roback (1983: p. 43)*
Macropelopia decedens (2)	-	*5*	-	-	*Roback (1978: p. 196)*
Meropelopia sp. (283)	*1*	*2*	*3*	*2.8*	
Radotanypus florens (1)	-	*16*	-	-	*Bolton (1992: p. 151)*
Trissopelopia ogemawi (14)	*4*	*5.5*	*7*	*39.5*	*Fittkau & Roback (1983: p. 71)*
Zavrelimyia sp. (194)	*1*	*2*	*3*	*2.8*	*Fittkau & Roback (1983: p. 73)*
Diamesa sp. (27)	*2*	*3*	*4*	-	*Oliver (1983: p. 119)*
Pagastia orthogonia (14)	*2*	*4.5*	*9*	-	
Odontomesa ferringtoni (4)	*1*	*5.5*	*16*	-	
Prodiamesa olivacea (12)	*2*	*4.5*	*6*	*36.0*	
Brillia parva (spring em.?)	-	-	-	-	
Chaetocladius piger (spring em.)	-	-	-	-	
Corynoneura sp. 5 (spring em.?)	-	-	-	-	
Eukiefferiella devonica gr. (32)	*2*	*3.5*	*5*	*14.2*	
Heleniella sp. (spring em.?)	-	-	-	-	*Cranston et al. (1983: p. 174)*
Heterotrissocladius mar. (10)	*4*	*6*	*9*	-	*Saether (1975: p. 32)*
Metriocnemus eurynotus (spring em.?)	-	-	-	-	
Parachaetocladius sp. (2)	-	*5.5*	-	-	*Cranston et al. (1983: p. 185)*

Attachment 3, Table 2 continued. List of cool-water macroinvertebrate taxa.

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Taxa (n)	25th %ile No. taxa	50th %ile No. taxa	75th %ile No. taxa	75th %ile % taxa	References
Parametriocnemus sp. (793)	*1*	*2*	*3*	*3.2*	*Cranston et al. (1983: p. 187)*
Psilometriocnemus tri. (1)	-	*11*	-	-	*Cranston et al. (1983: p. 195)*
Rheocricotopus emin. (spring em.?)	-	-	-	-	
Thienemanniella boltoni (4)	-	*8.5*	-	-	
Polypedilum albicorne (43)	*2*	*4*	*5*	*10.27*	*Maschwitz & Cook (2000: p. 37)*
Polypedilum aviceps (173)	*2*	*3*	*5*	*10*	
"Constempellina" n. sp. 1 (2)	-	*3.5*	-	-	
Micropsectra sp. (152)	*1*	*1*	*3*	*3.8*	
Paratanytarsus n. sp. 1 (174)	*2*	*3*	*5*	*12.6*	
"Stempellina" n. sp. 1 (spring em.?)	-	-	-	-	
Zavrelia n. sp. 1 (spring em.?)	-	-	-	-	

Definition of Cool water Benthic Macroinvertebrate Taxa

Cool water macroinvertebrates are taxa that primarily inhabit streams that maintain a daily average summer water temperature below about 18°C. Daily maximum water temperatures may exceed 20°C in summer months, but rarely greater than 23°C. (see Ohio EPA b, 2002). Cool water taxa were in part chosen by analysis of the 25th, 50th, and 75th percentile statistics of the number of cool water taxa at a taxon's collection sites and the 75th percentile of the percent cool water taxa at the collection sites during the summer collection period (June 15 to September 30). Cool water taxa generally were expected to have the 25th %ile ≥ 2, 50th %ile ≥ 3, and 75th %ile ≥ 5 for the number of cool water taxa, and the 75th %ile ≥ 7 for the percent of cool water taxa at collection sites. Information in the published scientific literature was also considered when assigning taxa to the cool water list. Some species emerge in the spring and their larvae are not present during the summer collection period. For these taxa, the nature of the collection sites were taken into account along with an analysis of the associated taxa and a review of the scientific literature to determine if the taxa should be included on the cool water taxa list.

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Attachment 4

Optional Pebble Count Method to Determine Substrate Percentages

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<u>SUBSTRATE CHARACTERISTICS:</u> (Optional Pebble Count Method)

Zig-Zag Pebble Count Results:Time Spent (minutes):_________

Particle Size (mm)	**Dry Channel**	**Wetted Channel**		**Total Wetted Channel**	**Percent Wetted Channel**	**Percent Cumulative**
		Riffle	**Pool**			
Bedrock						
Boulder >256 mm						
Large Cobble (129-256 mm)						
Small Cobble (65-128 mm)						
V. Coarse Gravel (33-64 mm)						
Coarse Gravel (17-32 mm)						
Med. Gravel (9-16 mm)						
Fine Gravel (5-8 mm)						
V Fine Gravel (2-4 mm)						
Sand (<2 mm)						
Silt						
Clay Hardpan						
Detritus						
Column Total						

2. Comments re: Substrate:

Office Calculations:

Total Counts Made (sum all columns above) _________________ (Note: at least 100 counts required)

Percentages for Substrate Types: (number counted for each substrate / Total Counts x 100)

Boulder ______ Cobble _______ Gravel ______ Sand ______ Silt/Clay ______ Detritus/Woody Debris_______